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TENTH ANNUAL REPORT
of
Pasture Research
in the
Northeastern United States
State College, Pennsylvania
1946

1946

Tenth Annual Report
of
Pasture Research
in the
Northeastern United States

U. S. Regional Pasture Research Laboratory
State College, Pennsylvania

Division of Forage Crops and Diseases
Bureau of Plant Industry, Soils, and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture
and
The Agricultural Experiment Stations
of the
Twelve Northeastern States
Cooperating

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Copies of this report were sent to all organizations involved in the development of the present pasture research program in the twelve Northeastern States and in addition one copy to the Director of each of the following State Agricultural Experiment Stations--Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Carolina, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, Virginia, and Wisconsin; three copies to Canada as follows--Dean of Agriculture, University of Saskatchewan, Saskatoon, and Dominion Agrostologist and Main Library, Department of Agriculture, Ottawa; and one copy to each of the following--The Library, School of Agriculture, Cambridge, England; Director of the Welsh Plant Breeding Station, Aberystwyth, Wales; Director of the Swedish Seed Growers Association, Savalof, Sweden; Director of the Waite Agricultural Research Institute, Adelaide, Australia; Librarian, Division of Plant Industry, Council for Scientific and Industrial Research, Canberra City, A.C.T., Australia; Director, Grasslands Division, Palmerston North, New Zealand.

B.

THE LABORATORY STAFF

R. J. Garber Director

Marion F. McCartney Secretary

Project leaders

J. T. Sullivan Physiologist

V. M. Myers Geneticist

V. G. Sprague Agronomist

R. R. Robinson Associate Agronomist

K. W. Kreitlow Associate Pathologist

Technical Assistants

K. G. Brown Cytogenetics

E. J. Dollinger Cytogenetics

Helen D. Hill Cytogenetics

A. G. Lueck Agronomy

COLLABORATORS

B. A. Brown, Connecticut

C. B. Bender, New Jersey

C. E. Phillips, Delaware

C. E. F. Guterman, New York

C. H. Moran, Maine

C. B. Knott, Pennsylvania

W. B. Kemp, Maryland

Irene H. Stuckey, Rhode Island

V. G. Colby, Massachusetts

A. R. Midgley, Vermont

F. S. Prince, New Hampshire

G. G. Pohlman, West Virginia

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REPORT
OF
PASTURE RESEARCH
IN THE
TWELVE NORTHEASTERN STATES
FOR THE CALENDAR YEAR 1946

INTRODUCTION

The first postwar year was marked by a continued great demand for human food; in fact at world levels, available supplies were far short of demand. According to agricultural economists this situation is likely to continue well up into 1947 or even into 1948 particularly with reference to some commodities. There is nothing either in the foreign or domestic situation that would warrant a slow-up in agricultural production at this time.

With present high prices for livestock there is a tendency to retain and feed concentrates in the Middle West where the bulk of them are produced. This situation has aggravated the shortages and consequently increased costs of such feeds for the northeastern farmer. Effective solution of these problems continues to be production of high quality forage.

During the year 1946 the Pasture Collaborators held two meetings, one in New York City, February 5 and 6, and the other in State College, July 9 and 10. Somewhat detailed reports of these meetings were prepared and mailed to interested persons so only a very brief account will be given here.

The winter meeting was concerned primarily with a review and discussion of pasture research carried on in the region during the war period. The trend toward a more applied type of research at the Laboratory was noted and it was generally agreed that it would be advantageous for the region as a whole to have the Laboratory, in its research program, again give relatively more emphasis to fundamental studies as was done before the war. Plans to bring this about are being developed.

The summer meeting at State College was devoted primarily to inspecting the plant material and field experiments that had been developed during the past three or four years. Steps were taken to integrate more closely the research work at the Laboratory with that at the state stations. Plans were developed for a cooperative breeding and testing program. The Director of the Laboratory was asked to name two committees whose responsibilities would be the development of plans for regional studies of soil aspects of pasture management and of other aspects of pasture management. It was suggested that the present

committee on climate be enlarged and asked to assume the responsibility for developing plans for studies of both climate and non-soil aspects of pasture management. R. R. Robinson, B. A. Brown, Michael Peech, and G. G. Pohlman were appointed to the soils committee and V. G. Sprague, E. R. Biel, H. A. MacDonald, and J. W. Marvin to the other one.

During the year three personnel changes occurred among the Collaborators. Irene H. Stuckey was appointed to represent the Rhode Island Agricultural Experiment Station. S. I. Bechdel retired and was replaced by C. B. Knodt of the Department of Dairy Husbandry of The Pennsylvania State College. At the request of G. L. Schuster, he was replaced by C. E. Phillips, Head of the Department of Agronomy of the University of Delaware. V. M. Myers of the Laboratory staff left August 11 for a 6-months' tour of duty in Japan and Korea.

In organizing the Tenth Annual Report of Pasture Research in the Northeastern States a slight departure has been made from its predecessors in that the present report has been divided into three parts and a more detailed table of contents has been substituted for the index of Part III. Part I consists primarily of brief accounts of progress on work covered by formal project outlines drawn up between state stations and the Laboratory; Part II on work underway at the Laboratory but not carried on in direct cooperation with state stations; and Part III on pasture research at State Stations but not carried on in direct cooperation with the Laboratory. This division into parts has been made merely for convenience in presentation. In a very real sense all pasture research carried on in the Northeastern States by state and federal agencies is cooperative. The responsibility for the preparation of Part I rested largely with the project leaders concerned and of Part II with the Laboratory staff. The responsibility for compiling each state report in Part III was assumed by the Collaborator of that state.

The list of publications at the end of the report may not be complete for the year but it does include all those originating at the Laboratory and those originating elsewhere in the region, citations to which were sent in with the progress reports.

PART I

COOPERATIVE RESEARCH BETWEEN STATE STATIONS
AND THE LABORATORY.

Before presenting the progress reports covered by formal project outlines, it may be desirable to give a brief account of further developments regarding foundation seed stocks of Ladino clover (1945 Annual Report, page 3) and regional strain testing initiated during the year.

FOUNDATION SEED STOCK OF LADINO CLOVER

In accordance with plans, there were entered in the pool for further testing to determine general adaptability and freedom from contamination with white clover, Ladino clones as follows: 28 from Ottawa, Canada, 52 from the Pasture Laboratory, and 4 from the New Jersey Agricultural Experiment Station. The clones supplied by the Pasture Laboratory originated from plant and seed collections made in various places of the Northeastern Region. In order to determine which clones will finally be eligible to provide the foundation seed stock, tests are being conducted at 5 state stations within the region and 3 state stations outside the region in addition to those being carried on at Ottawa, Canada, and the Pasture Laboratory. Early in December, 10 plants each of 52 clones were sent to the Soil Conservation Service Nursery in Bellingham, Washington, for increasing vegetatively, preparatory to establishing stocks for foundation seed.

REGIONAL STRAIN TESTING

As already mentioned in the Introduction, plans were developed during the year for more adequately testing in the region any new strains that may be developed by breeding. Seed of a new strain of Kentucky bluegrass developed at the Pasture Laboratory was sent late in the year to each of the following state experiment stations: Connecticut (University of Connecticut), New York (Cornell University), Massachusetts, West Virginia, and Wisconsin. Clones of orchard grass, brome grass and Ladino clover that have appeared to possess some value as breeding stock in the Laboratory nursery at State College, Pennsylvania, were made available last September to the cooperating state stations indicated for further testing: Massachusetts, 170 clones of brome grass and 81 clones of orchard grass; New Jersey, 18 clones of orchard grass; New York (Cornell University), 173 clones of brome grass, 284 clones of orchard grass and 50 clones of Ladino clover; Rhode Island, 163 clones of orchard grass and 50 clones of Ladino clover. One hundred thirty-three clones of orchard grass were sent to the Division of Forage Crops and Diseases for further testing at Beltsville, Maryland, and 76 clones were received

from the Division for testing at State College, Pennsylvania. Eighty-six clones of orchard grass were also received at the Laboratory from the Dominion Experimental Farms, Ottawa, Canada.

DACTYLIS GLOMERATA BREEDING
(WITH MARYLAND AND
DIVISION OF FORAGE CROPS AND DISEASES)

Title: Selection, Inbreeding, and Crossing to Obtain Orchard Grass Strains Adapted Particularly for Pastures in Maryland.

Leaders: For the Maryland Agricultural Experiment Station - W. B. Kemp.
For the Division of Forage Crops and Diseases - M. A. Hein and R. E. Wagner.
For the Pasture Research Laboratory - W. M. Myers.

At Beltsville, Maryland

Selection Nursery. Seventy-six selections were made from the 1944 nursery. These were placed in four different maturity groups on a basis of date of flowering notes taken this summer. Of the 76 plants selected, 20 were placed in the AI group, 22 in the AII, 13 in the AIII, and 21 in the AIV group. Sufficient clonal material was taken from each plant in August for polycross nurseries to be established at Beltsville and State College, Pennsylvania.

Polycross Nurseries. Two polycross nurseries will be established at Beltsville in the spring of 1947. One of these will comprise the 76 selections made at Beltsville and the other will consist of 243 individual selections made at the Pasture Research Laboratory. One hundred thirty-three of the 243 are selected clones from a source nursery and the other 110 are selections from polycross progenies of selected clones. This material is being carried over in the greenhouse.

Isolation Blocks. Because of the variability within the five Beltsville isolation blocks, it was agreed to select the few most outstanding plants in each block and discard the remainder. The new selections will constitute the new replacement isolation blocks to be established in the spring of 1947.

Further Selection and Increase of Maryland Strains. The selection and increase nursery of the Maryland Hay and Pasture strains established in the fall of 1945 was maintained during 1946. The nursery will be carefully rogued during 1947 and seed will be harvested for increase and testing purposes. Selection of superior plants will also be made.

Strain Trials at the Agricultural Research Center. This test consists of 16 strains of orchard grass seeded in the fall of 1944 in mixtures with red and Ladino clover to determine their performance under actual

grazing conditions. The strains included in the test are Tammisto, Finnish Late Hay, Brage, S-26, S-143, the Maryland Hay and Pasture selections and nine new strains from isolation plots grown at Beltsville and the Pasture Research Laboratory.

Plant counts taken with the point quadrat in the fall of 1945 showed the stands of Maryland Hay and Maryland Pasture strains to be outstanding. Isolation Plot 6 and Finnish Late Hay were the poorest of the group. Similar counts were made in the fall of 1946 and the Maryland Hay and Pasture strains were again best but the Isolation Plot 5 and Finnish Late Hay plots were lowest in percentage of grass. Isolation Plot 6 ranked eleventh out of the 16 in 1946.

Yields of the grass and clover mixture were taken from each plot on three different harvest dates during 1946. Isolation Plot 1 was high among the strains with a yield of 5040.3 pounds of dry matter per acre followed by Maryland Hay with 4850.3 pounds, Isolation Plot 5 with 5805.5 pounds and Isolation Block XI with 4729.8 pounds. Tammisto with a yield of 3375.1 pounds was the only strain that produced less than 4000 pounds. Although statistical analyses have not yet been calculated on these data, the differences between many of the strains would undoubtedly be non-significant.

In many cases the correlation between percentage of grass and yield is rather poor, indicating that the yield of clover is of prime importance in these data. A notable exception to this is the Maryland Hay strain which ranked first in stand and second in yield. The Maryland Pasture strain was second in stand but 13th in yield, Isolation Block XIII third in stand and fifth in yield, Tammisto fourth in stand and 16th in yield, Isolation Plot 2 fifth in stand and seventh in yield, and Isolation Block XI sixth in stand and fourth in yield. Isolation Plot 1, the high yielder of the test, ranked tenth in stand.

At State College, Pennsylvania

New Introduction and Additional Polycrosses. A new source nursery consisting of approximately 2000 plants was established. This material includes 172 clones kindly sent to the Laboratory by the Dominion Experimental Farms, Ottawa, Canada. Additional polycross tests were established involving a total of 319 clones, 76 of which were received from the Plant Industry Station, Beltsville, Maryland. The other clones were selected at State College, Pennsylvania.

Production of Improved Strains. Seed from 89 plants selected from the polycross planting of orchard grass in 1943, with commercial as a check, was planted in four randomized blocks in 1945. Green weights per plot were harvested in 1946, but have not yet been summarized.

Strain Test. Green weights of small replicated plots of 16 varieties of orchard grass established in 1945 (1945 Annual Report, page 5) showed Maryland Pasture Hay first in total yields and among the first two

places in three of four harvests; State College Isolation Plot 1 second in totals and among the first three places in two harvests; State College Isolation Plot 5 in third place in totals as well as in two of the four harvests. Sixteenth in total and in two of the harvests was Tammisto, fifteenth was the commercial check, and Beltsville X was among the three lowest ranks in three of four harvests. These yield studies will be continued next year.

MEDICAGO SATIVA BREEDING
WITH CORNELL (NEW YORK), NEW JERSEY,
RHODE ISLAND, AND THE DIVISION OF
FORAGE CROPS AND DISEASES

Because the National Alfalfa Improvement Conference met at Logan, Utah, on August 7 to 9, 1946, it was decided that the Eastern Alfalfa Improvement Group should not meet during 1946. It is tentatively planned that the next meeting of the Eastern Group may be held in State College, Pennsylvania, some time during the summer of 1947.

Titles: Breeding Improved Alfalfa for the Eastern United States.
 Breeding and Testing Alfalfa for Pasture and Forage.
 Alfalfa Breeding.

Leaders: For the Cornell University Agricultural Experiment Station
 - S. S. Atwood, R. P. Murphy, H. A. MacDonald, and Paul
 Grun.
 For the New Jersey Agricultural Experiment Station - G. H.
 Ahlgren.
 For the Rhode Island Agricultural Experiment Station -
 T. E. Odland.
 For the Division of Forage Crops and Diseases - H. M.
 Tysdal.
 For the Pasture Research Laboratory - W. M. Myers and
 K. W. Kreitlow.

At Ithaca, New York

Using seed supplied cooperatively by the Nebraska Agricultural Experiment Station and the Division of Forage Crops and Diseases, Observation and Advanced Nurseries were established in both 1945 and 1946. The stand in the 1945 Observation Nursery was uneven due mostly to damping-off and competition from weeds; no yields were obtained, but notes were taken throughout the summers of 1945 and 1946 on vigor, leaf-hopper damage, and leaf-spot infection. The 1946 Observation Nursery was severely set back by leaf hoppers during July, but it was dusted once with DDT, and a very vigorous recovery growth was obtained. The 1945 Advanced Nursery plots killed out severely during the spring of 1946. Notes were taken on the differential survival, and the plots were then discarded. Most of the same seed lots, together with a few single crosses from Nebraska, were sown in 1946 in plots at Churchville, New York, where a satisfactory stand was obtained. The 1946 Advanced

Nursery was sown at Ithaca, but the seedlings grew poorly throughout the summer and their growth was extremely retarded by both leaf hoppers and leaf spot, so it is doubtful whether satisfactory plots will be obtained from this seeding.

Most of the C-number clones were supplied by the Nebraska Agricultural Experiment Station and the Division of Forage Crops and Diseases. These clones, along with certain selected New York clones, were grown in the greenhouse during the 1945-46 winter season, and all were tested for self-fertility. Crosses were made between certain clones, and the F_1 progenies were planted in the field in 1946. Some of these were selected for greenhouse study in 1946-47. Cuttings from all selected plants were transplanted to the field in 1945 and 1946, and notes have been taken on their field behavior. A few New York clones that have been observed as spaced individuals during 1944, 1945 and 1946, following selection in the field, are being sent to Nebraska for including in an Observation Polycross Nursery in 1947.

Studies have been initiated on the cytological behavior of certain clones in relation to their fertility behavior. This work is supported in part by the Division of Forage Crops and Diseases and may be included later as a separate project.

At New Brunswick, New Jersey

The 31 alfalfa clones partially evaluated in 1945 were studied further during 1946. That inoculation with the wilt organism was highly effective was indicated by complete loss of 13 of the clones due to this disease. Others showed symptoms of infection but managed to survive the summer.

Although all of these clones were selected on the basis of apparent superiority from old fields in New Jersey or from the Atlantic variety many have proved inferior in these preliminary clonal row tests. Of the remaining clones seven are considered of the spreading type and the rest erect. Considerable difference in leaf-hopper resistance has been recorded ranging from almost no infection to very severe. Differences in susceptibility to Pseudopeziza medicaginis were also just as marked.

Yield records on a green-plant basis ranged from nine grams per plant to 1018. Two very promising clones, out of Atlantic, numbered 27 and 28 in these tests, have been isolated. These averaged in green weight for one cutting 932 and 1018 grams per plant. They had good color and as yet have escaped the wilt disease.

Superior appearing clones have been secured from old fields in New Jersey again this past season and these are being increased in the greenhouse. They will be inoculated for wilt when set into the field next spring.

At Kingston, Rhode Island

Yields and other data were obtained on 44 different hybrids, strains, and varieties planted in 1945. A hybrid developed at the Rhode Island Station (Al97) produced the largest yield (5.0 tons of dry matter per acre). Atlantic, Baltic Hecker, Nebraska 49-1282, Nebraska 39-1268, Nebraska 39-1272 and Buffalo also gave satisfactory tonnage.

At Beltsville, Maryland

The work at Beltsville is primarily concerned with the evaluation of polycrosses and clones under eastern conditions, and with hybridization and selection for leaf-hopper resistance and selection for the spreading habit of growth. Most of the promising Alfalfa Conference clones, including some from the eastern states, together with polycrosses of a number of them, have been planted at Beltsville. No yields have been taken, the evaluations being based on observations of such characters as vigor of growth, color, resistance to insects and diseases, and general desirability.

A number of crosses were made involving a very pubescent introduction from Saudi, Arabia, which appeared to have a high resistance to the potato leaf hopper. Segregating populations of these crosses will be planted in an observation nursery for selection of leaf-hopper resistant plants. The segregating populations are also being inoculated with the bacterial wilt organism, so that only resistant types will be placed in the observation nursery.

Several alfalfa plants have been found (chiefly from old fields but also as segregates in the breeding program) which have rhizomes. A number of these have been intercrossed and crossed with other desirable clones to find a hybrid or synthetic which could be expected to come true to this type, and at the same time be well adapted for eastern conditions. This part of the project is just started and no results have been obtained to date.

The entire project at Beltsville is relatively new, but observation tests indicate the great value of checking, under eastern conditions, the new materials developed throughout the alfalfa breeding program.

At State College, Pennsylvania

Source Material. A source nursery of approximately 4900 plants was established in the spring of 1946. The plants came primarily from varieties, strains, polycrosses, synthetics, and single crosses used in the midwestern alfalfa breeding program.

Evaluation of Clones. Eighty-eight individual plant selections were made from the 1945 nursery (1945 Annual Report, page 8) on the basis of general vigor, resistance to leaf diseases, leafiness, damage from leaf hopper and seed set. These selections were brought into the greenhouse, increased clonally, and are now undergoing a wilt test.

A total of 86 clones which survived the 1945 wilt test (1945 Annual Report, page 8) was increased vegetatively and planted in four replicated 5-plant rows in the spring of 1946. Twenty-two clones received from Nebraska were similarly planted for further observations under State College conditions.

Crosses. Clones of 25 F_1 crosses, involving selections from creeping types, wilt-resistant forms, and the Atlantic variety as parents, were sent to the Nebraska Agricultural Experiment Station at Lincoln in the spring of 1946 for the production of F_2 seed. Seed was produced and returned to the Laboratory the following fall. Seedlings from this material are now included in the wilt test being conducted in the greenhouse.

Advanced Nursery. In cooperation with the Department of Agronomy of The Pennsylvania State College 64 strains of alfalfa were seeded in plots in a simple lattice design in the spring of 1946.

POA PRATENSIS BREEDING (WITH PENNSYLVANIA)

Title: Breeding Kentucky Bluegrass for Improved Pasture Types.

Leaders: For the Pennsylvania Agricultural Experiment Station - H. B. Musser.

For the Pasture Research Laboratory - W. M. Myers.

Activity by the Pennsylvania Experiment Station this year has consisted in establishment of a seed multiplication nursery consisting of approximately 200 plants each of 24 previously selected strains showing a high degree of uniformity in progeny tests. Seed from this nursery will be used for establishment of turf quality test plots. Plantings of 30 plant progenies of 14 plant selections also have been made for preliminary progeny uniformity and other nursery data on these selections.

The above listed selections were chosen for seed multiplication for further testing largely on the basis of preliminary data which indicate their possible adaptation for specialized turf use.

Seed of strain 37KB143(223) which was developed at State College was sent to several state stations in the region in comparison with commercial bluegrass.

POA PRATENSIS AND PHLEUM PRATENSE BREEDING
(WITH WEST VIRGINIA)

Title: Breeding and Improvement of Pasture Grasses and Legumes.

Leaders: For the West Virginia Agricultural Experiment Station -
Collins Veatch and J. G. Leach.
For the Pasture Research Laboratory - W. M. Myers and
K. V. Kreitlow.

At Morgantown, West Virginia

The studies on Ustilago striiformis, stripe smut of bluegrass, have been continued as extensively as available time and help would permit.

A study was made of the cytology of the fungus as grown on agar medium and the following significant facts were learned. The fungus is normally homothallic. It produces both haploid and diploid (synkaryotic) vegetative mycelium and it has no true dikaryophase. The chlamydospore contains a large nucleus, apparently diploid, that appears to undergo reduction division soon after spore germination. The germinating spore does not form a true promycelium but produces a branched germ tube of indeterminate growth. Sporidia are not produced and hyphal fusions have not been observed. A partial reassortment of nuclei takes place in the branching germ tube or resulting mycelium, and karyogamy occurs without an intermediate dikaryophase. The synkaryotic cells multiply vegetatively forming a characteristic fragmenting mycelium readily distinguishable from the radiating haploid mycelium. The diploid synkaryotic mycelium in its typical form of growth breaks up readily into short fragments, each cell of which contains a single large apparently diploid nucleus. Each cell of the fragmenting synkaryotic mycelium may be transformed directly into a chlamydospore or it may divide to form new synkaryotic cells.

Several selections have been tested for resistance and at least three strains show indications of resistance although further inoculations are necessary before final conclusions are justified.

Seeds of several species of Poa have been obtained and seedlings are being tested for susceptibility to smut but no conclusive results are yet available.

All possible seed was saved of the strains which have proved resistant to bluegrass smut Ustilago striiformis, according to the greenhouse tests developed by the Department of Plant Pathology. This seed has been planted to secure as much increase as possible. Plans are being made to make clonal increases of these disease-resistant strains to be planted in plots for seed production.

At State College, Pennsylvania

Seed was harvested from smutted timothy plants growing in a nursery in the field during the summer of 1943. The seed was stored until winter and then one-half was treated several minutes in 1:500 $HgCl_2$ while the other one-half was left untreated as controls. Both treated and untreated seeds were then sowed in flats of steamed soil in a greenhouse and the plants examined periodically for development of stripe smut. When the experiment was concluded, no smutted plants had developed among 550 seedlings that emerged from the treated seeds. Among 500 seedlings that emerged from untreated seed, 18 (3.5 percent) were smutted. Additional seed was obtained from smutted plants in the greenhouse during the spring and summer of 1944. This seed was harvested and stored later (winter of 1945-46) along with the seed also from smutted plants harvested in the summer of 1945. Of 343 seedlings secured from the 1944 seed none was smutted and of 877 seedlings obtained from the 1945 seed 51 (5.8 percent) were smutted.

In the summer of 1946, slightly more than 10 grams of seed were harvested from smutted plants growing in the greenhouse. The seed was divided into 1-gram lots and treated with the following dust fungicides: New Improved Ceresan, Semesan, Copper Carbonate, Yellow Cuproside, 2 percent Ceresan, and Spergon. An untreated lot was left as a control. The seeds were sown in the greenhouse and the plants will be examined periodically for smut.

Since storing smut-contaminated seeds longer than one year appears to affect surface sterilization, samples of seed harvested from smutted plants in 1946 are being planted periodically to determine how long chlamydospores may remain viable on the seed surface.

TRIFOLIUM REPENS BREEDING (WITH NEW JERSEY)

Title: Breeding White Clover for Pasture.

Leaders: For the New Jersey Agricultural Experiment Station - G. H. Ahlgren.

For the Pasture Research Laboratory - W. M. Myers.

Progeny Test of Diallel Crossing System. The production of seed from three crosses is now being attempted. These are plants 6-5x6-16, 6-10x6-13, and 6-9x6-12. Cuttings from each plant for each cross were alternated in the field to secure as good cross-pollination as possible.

Each cross is being made under the best isolation conditions available on the college property. As far as is known there are no wild or other clover plants within one-fourth of a mile of any isolation block.

While the clones grew satisfactorily during 1946 little seed was produced; therefore, no attempt was made to collect any except from one cross which produced relatively more seed than the other two.

Open-pollinated Breeding System. Additional seed was collected during the summer of 1946 from this isolation block (1945 Annual Report, page 13). The seed supply from this source has now been built up to about two pounds. The block is being maintained to insure more seed as needed. The two pounds of seed is being stored for comparative tests with that from the diallel crossing system.

TRIFOLIUM REPENS, TRIFOLIUM PRATENSE
AND PHLEUM PRATENSE BREEDING (WITH NEW HAMPSHIRE)

Title: The Improvement of Ladino Clover, Red Clover, and Timothy by Selection and Breeding.

Leaders: For the New Hampshire Agricultural Experiment Station - Ford S. Prince, L. J. Higgins, and P. T. Blood.
For the Pasture Research Laboratory - V. M. Myers.

At Durham, New Hampshire

Ladino Clover. Nine parent plants have been chosen as a result of several years' crossing and testing as having good combining ability, as well as excellent competitive features in heavy grass seedings. These are being propagated clonally in the greenhouse, and additional crosses among them are to be made. During the season, clones of Ladino from several cooperating stations were grown as well as seedlings from our own breeding program. The superior ones have been brought into the greenhouse for propagation and for possible breeding.

Red Clover. Descendants of the 12 original families of red clover which showed a perennial tendency are being weeded out for disease susceptibility or for other causes. The more desirable ones are being intercrossed in the greenhouse for further propagation and testing. Farm tests of the seed harvested in 1945 are underway. Although no seed of the original strain was harvested in 1946, there is still seed on hand from the 1945 crop which will be used for testing.

Timothy. After two failures at testing the original parents of two timothy strains, due to causes beyond our control, a third attempt has been made which may be successful. The purpose of this testing is to weed out inferior parents of the two strains of timothy which are now under test. Additional material from Morgan Evans of Ohio and from other sources is being tested alongside of our timothy families for comparison.

At State College, Pennsylvania

New Source Nursery of Ladino. In the spring of 1946 there were space-planted in the field 100 plants from each of 11 lots of seed obtained from E. A. Hollowell of the Division of Forage Crops and Diseases. The sources of these 11 lots of seed were California, Oregon, Montana, and Italy. Selection will be made from these 1100 plants in the summer of 1947.

Selections from 1945 Ladino Polycross Block. During the spring and summer of 1946 the 267 clones planted in the 1945 Ladino polycross block (1945 Annual Report, page 14) were rated on winter survival, early spring growth, general vigor and plant spread, amount of flowering, and resistance to Pseudoplea leaf spot disease and to leaf hoppers. On the basis of these data 50 clones were selected for their superiority in most of the above-mentioned characteristics. Only one of the clones was definitely superior in all characteristics noted; but many of the clones, although superior in most of the desirable features, were rated low in at least one respect. Therefore, in an effort to introduce into the germ plasm of the progeny of a given clone the one or two features the clone may lack, appropriate crosses are to be made in the greenhouse during the winter of 1947. The 50 selected clones will be planted in a polycross block in the spring of 1947, with the aim of obtaining seed for progeny testing of the clones. These clones were also sent to New York and Rhode Island for further testing in those locations.

Yields of Polycross Progeny. Green weights of clippings from replicated plots of Ladino polycross progeny (1945 Annual Report, page 14) including a commercial check showed a tendency for certain strains to yield consistently well and better than the check.

MICRO-CLIMATE STUDIES (WITH VERMONT)

Title: Micro-climate and the Growth of Several Pasture Species.

Leaders: For the Vermont Agricultural Experiment Station - J. W. Marvin.
For the Pasture Research Laboratory - V. G. Sprague.

Micro-climate Data. A continuous record of several environmental factors has been kept for four years. These factors are relative humidity, precipitation, light intensity, soil moisture at three, nine and eighteen inches, air temperature at six feet and three inches, and soil temperature at soil surface and three inches below soil surface. These records are being continued and are similar to those previously reported.

Species Tests. One hundred plots of legume-grass mixtures were seeded in 1943. The legumes were Ladino, alfalfa, red clover, sweet clover and birdsfoot trefoil. The grasses were reed canary, timothy, orchard and brome. The plots on a heavy clay soil received an application of lime and

400 pounds per acre of 8-16-16 fertilizer before seeding. They were given a second treatment of one-half ton of lime and 400 pounds per acre of 0-16-16 fertilizer in the fall of 1944 and again in the fall of 1945.

The yields for 1944 and 1945 are reported in the 1944 (page 13) and 1945 (page 15) Annual Reports. The sweet clover plants died the first winter. Of the four remaining clovers, the highest yields of Ladino and birdsfoot trefoil were in 1945, while the highest yields of alfalfa and red clover were in 1944. Of the grasses, reed canary outyielded the others, with brome and orchard next, and timothy giving the lowest yield.

The plots were cut once in 1946 and had become almost entirely grass plots. In addition to sweet clover, which died the first winter, Ladino and red clover died the winter of 1945-46. A botanical separation showed less than 10 percent alfalfa, and the birdsfoot trefoil plots varied from 1 to 12 percent. It should be mentioned that the percent of birdsfoot trefoil remained fairly constant in 1944 and 1945 and decreased in 1946.

Table 1. Total yields in pounds per acre of the several grass-legume mixtures in 1946.

	: Reed	:	:	:	:	:	:
	: canary	: Brome-	: Orchard	: Timo-	: No	:	:
	: grass	: grass	: grass	: thy	: grass	: Average	:
Ladino clover	: 3490	: 3080	: 2038	: 2670	: 1772	: 2610	:
Alfalfa	: 3458	: 3108	: 2070	: 2715	: 2120	: 2694	:
Red clover	: 2498	: 2555	: 2390	: 2214	: 1815	: 2294	:
Birdsfoot trefoil	: 2540	: 2507	: 2010	: 3440	: 2120	: 2523	:
Sweet clover	: 1750	: 2773	: 2221	: 2315	: 1837	: 2179	:
Average	: 2747	: 2805	: 2146	: 2671	: 1933	:	:

It would seem that under the management conditions used in this experiment, birdsfoot trefoil alone persisted into the third year but did not increase in stand. Inasmuch as the plots have reverted to a climax vegetation of grass with the loss of the clovers, this phase of the work is concluded.

NUTRITION STUDIES (WITH PENNSYLVANIA)

Title: Measurement of the Nutritive Value of Pastures and of Pasture Plants.

Leaders: For the Pennsylvania Agricultural Experiment Station - R. V. Swift and J. K. Thornton.

For the Pasture Research Laboratory - J. T. Sullivan and V. G. Sprague.

During 1946 forage was removed from the plots three times. Yield data were obtained from the first cutting only. Nitrate of soda was applied at the rate of 200 pounds per acre on the grass plots in mid-September. No treatment was given the legume plots. The alfalfa plots became so thin and weedy that it was felt desirable to plow and reseed them. This was done in August but it may be necessary to apply more seed in spring. Weeds were removed from the plots several times during the spring and summer.

The results of the digestion experiment with 22 sheep, indicating the reliability of average results in accord with the number of animals used, were published (page 74). These results will serve as a background in the interpretation of data to be obtained from the forage plots.

A meeting of the cooperating agencies was held October 16. The status of the project was reviewed and the need for a drier emphasized.

PASTURE MANAGEMENT EXPERIMENTS
(WITH PENNSYLVANIA)

Title: Evaluation of Grasses and Legumes for Hay, Grass Silage, and Pasture for Dairy Cattle.

Leaders: For the Pennsylvania Agricultural Experiment Station - C. B. Knodt, P. S. Williams, A. L. Haskins, and J. K. Thornton.

For the Pasture Research Laboratory - V. G. Sprague.

Systems of Grazing Management on Orchard Grass-Ladino Clover. The paddocks of orchard grass-Ladino clover on which grazing was begun in 1945 (1945 Annual Report, page 18) were continued in 1946. During the winter of 1945-46 considerable killing of Ladino clover occurred on all plots. The exact cause of killing was not determined but in addition to severe heaving the stolons were almost universally infected with Sclerotinia. Grazing was begun on the "early grazed" paddocks on April 24, about two weeks later than in 1945. The growing season was generally favorable for the growth of Ladino clover and it increased from about 7 percent in the dry weight of the herbage grazed in April and May to about 18 percent in August. Observations in October indicated the clover content had continued to increase during the fall.

In general, the amount of milk produced during the grazing season was slightly lower in 1946 than in 1945. The fat-corrected milk and the silage produced under the different management systems are presented in Table 2. Since supplementary feeding and management were identical for all cows except when they were on the plots, the differences observed in milk production can be attributed primarily to the herbage produced. It will be noted that the production from continuous grazing is about the same as that from either early or deferred rotational grazing. On these plots, the Ladino clover and orchard grass are still dominant, but ordinary white clover is becoming evident. While the weather during the 1946 grazing season was generally favorable, milk production from the Kentucky bluegrass paddocks was below that from orchard grass and Ladino clover.

Table 2. Production of milk from an orchard grass-Ladino clover association under several grazing management systems.

Grazing management system	1945		1946	
	Pounds	Tons	Pounds	Tons
	per acre,	per acre,	per acre,	per acre,
	FCM from	silage	FCM from	silage
	grazing	30% DM	grazing	30% DM
Early spring + rotational grazing	10,511	-	8,982	-
Deferred spring + rotational grazing	11,457	-	9,761	-
Continuous grazing	10,668	-	9,537	-
Early spring grazing + silage + rotational grazing	5,272	2.8	6,471	1.8
Silage + rotational grazing	7,199	3.0	4,529	5.2
Kentucky bluegrass	9,135	-	6,157	-

Evaluation of Several Grass-legume Mixtures for Grass Silage and Aftermath Grazing. The several grass-legume associations (first crop for silage and aftermath grazed, 1945 Annual Report, page 20) were used again for silage plus grazing in 1946. On these plots, as elsewhere, injury to Ladino during the winter of 1945-46 was severe. Alfalfa was not injured. Ladino clover constituted from 2 to 4 percent of the dry weight of the crop harvested for silage in late May and early June. The amount of clover steadily increased during the summer so that by fall it made up 22 percent of the grazed herbage of orchard grass-Ladino clover in early September. In association with timothy and brome grass it constituted from 48 to 56 percent of the dry weight of the herbage. While Ladino increased somewhat more in association with these two latter species, the percentage composition of the herbage may be misleading since neither brome grass nor timothy produced as much aftermath growth as orchard grass.

As is evident from Table 3 all associations yielded approximately the same amount of silage, bromegrass-alfalfa being highest and timothy-Ladino being the lowest. In 1946 the amounts of milk produced during the aftermath grazing did not vary as much as in 1945. It is especially interesting to note that the greatest yield of milk came from the orchard grass-alfalfa combination. The lowest milk yields from grazing were obtained from the bromegrass-Ladino and timothy-Ladino associations. Both of these latter species of grass provided a fair amount of herbage for the first grazing period but during the last period the grazed herbage was predominantly clover.

Table 3. Production of milk and silage from several grass-legume associations used for silage and aftermath grazing.

Grass-legume associations	1945		1946	
	Pounds	Tons	Pounds	Tons
	per acre,	per acre,	per acre,	per acre,
	FCM from	silage	FCM from	silage
	grazing	30% DM	grazing	30% DM
Orchard grass-alfalfa	4,275	5.6	5,956	5.8
Orchard grass-Ladino	9,634	4.7	5,050	5.7
Bromegrass-alfalfa	3,926	8.9	5,248	6.5
Bromegrass-Ladino	6,526	6.2	4,780	5.2
Timothy-Ladino	7,523	6.5	4,157	5.1

PASTURE MANAGEMENT EXPERIMENTS (WITH PENNSYLVANIA)

Title: Evaluation of Grasses and Legumes for Use as Poultry Pastures.

Leaders: For the Pennsylvania Agricultural Experiment Station - P. H. Margolf, E. V. Callenbach, J. K. Thornton, and H. W. Higbee.
For the Pasture Research Laboratory - V. G. Sprague.

Experiment 1. The orchard grass-Ladino clover ranges (1945 Annual Report, page 21) differing in intensity of grazing management were again pastured in 1946. Pasturing began on April 29 and continued to November 8. The populations at the beginning of the season of 100 and 200 poults were increased to 150 and 300 poults, respectively. Both areas were grazed rotationally. All equipment, shelters, feeders and waterers were moved daily and each area grazed required approximately three weeks for a rotation.

The poults were fed, in outdoor hoppers, a turkey-growing mash mixture and in addition scratch grain, whole oats, oyster shell and grit. Yields of herbage, as measured from representative areas clipped prior to each grazing period, were between 3,000 and 4,000 pounds per acre, air dry weight. Observations made during the growing season showed a predominance of the orchard grass compared to Ladino clover. Samples for

botanical separations of grass, legume and weeds have been made and calculations will be available at a later date. Normal growth was obtained from both groups of birds and although the areas were used for the second successive year mortality was very low.

Experiment 2. In the preference-grazing areas six species of grasses are grown in association with Ladino clover. Bromegrass made more mid-season growth in 1946 than it did in the previous year and was preferred by the turkeys. Tall oat grass was high on the preference list but this grass failed to give good ground coverage. Since the reed canary grass has become older it has produced a more dense sod and a coarser growth. While it was not eaten as well as in the first year it appeared to rate third in preference by the turkeys. Orchard grass showed a tendency toward bunchiness and rated fourth place. Kentucky bluegrass was not eaten very well and tramping soon matted it to the ground.

Botanical separations of pasture herbage revealed a decrease of approximately 60 percent in Ladino clover between September 1945 and May 1946. During the ensuing pasture season Ladino recovery was marked in brome, tall oat, and Kentucky bluegrass. While there was some recovery noted with orchard grass, tall fescue, and reed canary grass, it was less pronounced. These latter grasses grew more vigorously and crowded Ladino. Observational estimates continued to show an excellent stand of Ladino on all except the orchard grass plots.

PASTURE RENOVATION EXPERIMENTS (WITH CONNECTICUT)

Title: Grassland Renovation Trials in Connecticut.

Leaders: For the Storrs (Connecticut) Agricultural Experiment Station
- B. A. Brown and R. I. Munsell.
For the Pasture Research Laboratory - V. G. Sprague.

Accomplishments and results are:

1. The pasture, heavily disked in the fall of 1942 and seeded to Ladino clover in the spring of 1943, had only 3 percent Ladino clover in September 1946. Kentucky bluegrass, the predominating species before disking, had fully recovered from the tillage. A sort of "man bite dog" feature on this pasture is the almost pure stand of rank Ladino on a small area near the gate, where formerly an almost pure stand of Kentucky bluegrass was very thrifty, obviously due to the concentration of voidings on that area. It is very important to learn why Ladino has replaced Kentucky bluegrass in this case.

Birdsfoot trefoil also seeded in the spring of 1943 on another pasture but without tillage, occupied 2 percent of the area in September 1946. Although the pasture was closely grazed throughout the season, the trefoil appeared to be more prevalent than in any previous year.

2. Tests of weed killers to reduce competition of perennial grasses to seeded legumes in renovation of pastures were conducted. The several hundred small plots treated in former years were continued, chiefly to observe the establishment and prevalence of Ladino clover, used in all cases as a "test" legume. Good stands of Ladino were common where the herbicides had been effective in killing the grasses.

There have been some marked, but inconsistent differences in the effectiveness of a particular chemical applied at the same time in different years or at various dates in the same season. Therefore, during the fall of 1946, ammonium thiocyanate and Atlacide were applied at two rates, 100 and 200 pounds per acre, dry and in solution, and on four dates, namely, about September 1, October 1, November 1, and December 1. Better kills resulted from the October 1 and November 1 than from the September 1 applications. It seemed to make little difference whether the materials were added dry or in solution. The December 1 treatments will not be appraised until spring.

PASTURE RENOVATION EXPERIMENTS (WITH MASSACHUSETTS)

Title: Grassland Renovation Experiments in Massachusetts.

Leaders: For the Massachusetts Agricultural Experiment Station - W. G. Colby.
For the Pasture Research Laboratory - V. G. Sprague.

Herbage Yields. Comparative yields for 1946 were similar to those reported for 1945. Untreated grass sods produced about three-fourths ton of dry matter per acre; sods liberally top-dressed with lime and a complete fertilizer about two tons of dry matter per acre; and limed, fertilized and reseeded land about three tons of dry matter per acre. In addition to producing greater total yields, the reseeded areas also gave less seasonal fluctuation in herbage production.

Land Drainage. Some of the best potential pasture land in Massachusetts is now practically valueless because of poor drainage. Therefore, the first step in any renovation plan is to provide adequate drainage. One such area was found on the Tiffany Farm near Easthampton, Massachusetts. In this instance, about 2-1/2 acres of land were drained by blowing about 800 feet of ditch by means of dynamite. When a ditch can be made without "capping" (use of a fuse with each stick of dynamite), this is a very efficient and inexpensive means of draining potential pasture land. A ditch three to four feet in depth and six to eight feet wide can be made at a cost of not more than ten cents a running foot.

Tillage Machinery. The surface of freshly drained land is usually very rough and uneven and previous experience with a bog harrow under such conditions has not been particularly encouraging. A seedbed could be prepared but only after repeated diskings. On the Tiffany pasture a

machine using the "roto-tiller" principle and called a "Seaman Triple Tiller" was employed. This machine did an excellent job. In one operation it not only leveled but broke up and cut to pieces the many tough fibrous tussocks or hummocks. Where stones are not a serious factor, as is frequently the case with much of our poorly drained land, this machine shows real promise.

PASTURE RENOVATION EXPERIMENTS
(WITH PENNSYLVANIA, AT MONTROSE, AND
DIVISION OF FORAGE CROPS AND DISEASES)

Title: Pasture Renovation Trials in Northeastern Pennsylvania.

Leaders: For the Pennsylvania Agricultural Experiment Station -
C. B. Knodt and J. K. Thornton.
For the Division of Forage Crops and Diseases - M. A.
Hein.
For the Pasture Research Laboratory - V. G. Sprague.

The pasture renovation plots (1945 Annual Report, page 27 and two previous reports) seeded in the spring of 1943 were not harvested during 1946. In closing out this experiment it seems advisable to present a few summary statements drawn from this work.

It was possible to obtain good stands of red clover, Ladino clover, alfalfa and sweet clover on a poor stony pasture which had been limed, fertilized, and worked with a field cultivator. These legumes were of paramount importance in determining the yields of the plots. The grasses seeded in association with them were of minor importance, in part, perhaps, because the original grass sod was not completely killed. As a pasture legume on this soil Ladino clover appeared promising. Surprisingly good growth of alfalfa was obtained on this soil (Volusia) which is imperfectly drained.

PASTURE RENOVATION EXPERIMENTS
(WITH PENNSYLVANIA, AT STATE COLLEGE)

Title: Pasture Renovation Trials in Central Pennsylvania.

Leaders: For the Pennsylvania Agricultural Experiment Station - A. V.
Clyde and J. K. Thornton.
For the Pasture Research Laboratory - V. G. Sprague and R. R.
Robinson.

Yields were taken from the plots of the various grass-legume associations seeded in 1943 (1945 Annual Report, page 27). These cuttings were made on the alfalfa, Ladino, and red clover-alfalfa-Ladino clover associations and two cuttings on the red clover, sweet clover, and Lotus associations. As in the previous years, grass associations with alfalfa

outyielded all others by producing 6,734 pounds of dry matter per acre; red clover-alfalfa-Ladino clover associations with grass ranked second with yields of 5,088 pounds of dry matter per acre; Ladino-grass associations ranked third with yields of 4,628 pounds of dry matter per acre. The Lotus-grass associations were considerably lower in yield in 1946 than in 1945 due to killing of the Lotus during the winter of 1945-46. The cause of the loss of Lotus was not determined but appearances suggested that disease may have been a factor. For the first time, there was an indication, in the 1946 yields, that the several species of grass in the associations were an important factor in increasing the yield. Differences due to the several methods of seedbed preparation were less in 1946 than in previous years. This work was written up for publication in the Journal of American Society of Agronomy (page 74). Yields from the plots which were limed and top-dressed but not disked or seeded were similar to 1945 results: the untreated plots produced 671 pounds of dry matter per acre which was composed largely of weeds whereas the top-dressed area produced 3,449 pounds of dry matter composed largely of white clover and Kentucky bluegrass. This yield, however, was still about 2,000 pounds below that of the renovated areas.

In the renovation experiment started a year later, alfalfa was again the outstanding legume in grass associations producing 6,172 pounds of dry matter per acre. Lotus-grass associations were the lowest with yields of 4,385 pounds. Red clover-alfalfa-Ladino clover and red clover-Ladino associations with grass were intermediate with yields of 5,100 pounds per acre. The contributions of the various grasses in legume associations were not greatly different; timothy and reed canary associations each yielded about 5,400 pounds per acre and brome grass and orchard grass associations each about 4,800 pounds per acre.

The data on the effects of the various dates of harvest have not yet been summarized.

Time and Rate of Seeding. Yields were taken in 1946 from the renovated area seeded in 1945 to several grass-legume associations on dates with and without oats as a companion crop. In the year after seeding there were small but measurable differences due to the time of seeding. While there was no difference between the March 12 and the April 10 dates, seeding on May 10 reduced dry-matter yields between 400 and 700 pounds per acre the first harvest year. A small decrease in yield in 1946 was observable on both the April 10 and May 10 dates of seeding where a companion crop of oats removed for hay in 1945 was used. The effects of the various seeding rates of the grasses and legumes in the various mixtures were very small. Only where the rate of seeding of red clover was reduced from 6 pounds per acre to 3 pounds per acre did there appear to be any true difference and this amounted to only about 400 pounds per acre of dry matter. Botanical separations of the herbage from the various plots were made but these data have not yet been calculated.

PASTURE RENOVATION EXPERIMENTS
(WITH RHODE ISLAND)

Title: Pasture Renovation Trials in Rhode Island.

Leaders: For the Rhode Island Agricultural Experiment Station - Irene H. Stuckey.

For the Pasture Research Laboratory - V. G. Sprague.

Severe loss of Ladino clover resulted from winter injury during the 1945-46 season on the renovation area planted in 1944. The loss could not be attributed to age of the stand since other plots seeded in 1944 and 1945 were also severely damaged while the renovation area which had been planted in 1945 at another location showed no signs of winter injury at all. Because of the winterkilling, the total yields were slightly less than one-half and the percentage of legumes less than one-sixth of those recorded for 1945. However, the summer of 1946 was as favorable for Ladino clover as the previous winter had been unfavorable, and the recovery was better than might ordinarily be expected. By the time of the last cutting in September, the Ladino clover had increased from almost 0 to approximately 20 percent in each mixture.

The strips containing orchard grass had fewer weeds but there was also less open space for the Ladino clover to spread into, which may mean these areas will be a solid stand of orchard grass next year. The timothy was conspicuous for the first time in 1946. Neither the red clover nor the alsike clover had ever contributed very much to the yields on this pasture, and by 1946 only an occasional plant of red clover could be found. The land is so stony that machine mowing is impractical, and, since grazing is selective, it is to be expected that without regular mowing the quality of the vegetation will progressively deteriorate. Some of the decline in yields of the desirable forage was due to increase in weeds because of lack of mowing, as well as to winterkilling. This raises the question if pasture renovation is economically sound on excessively stony land. Studies of the initial cost against returns are needed on pastures similar to this.

On the area renovated in 1945, the percentages of legumes were lower than in the previous year but the yields were generally good, ranging from 4,023 to 7,666 pounds of dry matter per acre for the nine different mixtures. The differences between mixtures were more evident in 1946 than in 1945. Whether the poor growth of the smooth brome grass was due to the strain of brome grass used, or because the land was not adapted to brome grass, could not be determined. Brome grass has not yet shown any marked vigor in Rhode Island. Potassium deficiency symptoms were seen on several Ladino clover and alfalfa plants in 1946 as well as in 1945, in spite of 112 units of K_2O added in the fertilizer.

PASTURE RENOVATION EXPERIMENTS (WITH VERMONT)

Title: Pasture Renovation Trials in Vermont.

Leaders: For the Vermont Agricultural Experiment Station - A. R. Midgley
and K. E. Varney.

For the Pasture Research Laboratory - V. G. Sprague.

Time and Method of Seeding. Seeding of legumes on frozen ground in the spring (March 15) has continued to be better than early winter or the usual late spring seedings. When birdsfoot trefoil is planted at the usual time in the spring, after the land can be worked, it grows so slowly that the other legumes, grasses and weeds often crowd it out. When seeded on frozen ground, the seeds are covered sufficiently but not too deeply. The young plants seem to take advantage of the cool, wet spring weather and are then able to compete with the other plants and seedlings. It is possible that seed of birdsfoot trefoil germinates more readily and that the seedlings grow better at the lower temperatures. At any rate, it is quite well known that good stands of trefoil persist when the plant is allowed to reseed occasionally.

Some extensive "time of seeding" trials were started in the fall of 1946 on both a light sandy and heavy clay soil. Plantings were made in October (when plants normally drop their seed) and again in late November on frozen ground. These seedings will be compared with very early, medium and late spring plantings. The lots of these seeds together with brome grass were all weighed out in the beginning of the experiment in order to overcome variation in seed source.

Seeding trials are also being made by mixing the seed with phosphated and non-phosphated manure. Preliminary trials have given good results when the required amount of seed is spread on dairy manure before it is removed from the gutter. Adequate mixing seems to result when this is shoveled into the loader and applied with a good spreader. This would be a good method of reseeding renovated pastures if future trials continue to be successful.

Value of Different Plants for Renovation. Red clover is one of the easiest legumes to establish on renovated pastures where the seedbed is not ideal; and alfalfa, sweet clover and Ladino clover are in the same class when adequate lime and minerals have been used. Birdsfoot trefoil on the other hand is slow to get started and cannot stand competition during the seedling stage.

Different grasses showed marked differences in vigor and growth. Commercial orchard grass and tall fescue make a more vigorous growth than timothy or brome grass during the seeding year.

Brage orchard grass is leafier, somewhat later and almost as vigorous as the commercial strain, but the S-26 strain seems to have no virtue in this section.

Milton timothy has larger heads, is somewhat later, but yields less than the ordinary commercial strain. Non-creeping brome grass grew very poorly and it was considerably less vigorous than the creeping strain. Meadow foxtail grew well on the clay soils and produced a leafy undergrowth, but it was tough and unpalatable. It seeds very early and thus spreads readily in an ordinary hay field.

Time of Applying Nitrogen. It is difficult to justify large amounts of nitrogen on permanent pastures, primarily because it is usually less expensive to supply it through legumes. On meadows or pastures where most of the vegetation is grass, however, nitrogen is necessary and the time of applying it is important. Studies were made to determine the value of applying 60 pounds of nitrogen per acre in early fall (early October), late fall (late November) versus early spring (April 15). Good results were obtained in all cases, but spring applications were better on the several soil types where it was tested. However, if it is easier and more convenient to apply fertilizer in the fall, this may compensate for the slight reduction in yields over regular spring applications.

RUNOFF IN PASTURES (WITH PENNSYLVANIA AND THE RESEARCH DIVISION, SOIL CONSERVATION SERVICE)

Title: Moisture Relations in Pasture and Grassland Soils.

Leaders: For the Pennsylvania Agricultural Experiment Station and
the Soil Conservation Service - R. B. Alderfer.
For the Pasture Research Laboratory - R. E. Robinson.

Runoff was determined by the use of a Type F rainfall simulator on a number of pastures located mostly on Hagerstown soil in the vicinity of State College, Pennsylvania. Widely different intensities of grazing were included in these trials. Extreme variations in runoff were obtained. Soil samples were taken for determination of volume weight, moisture content, capillary and non-capillary porosity, degree of aggregation, organic carbon, and mechanical analysis. Although the soil studies have not been completed, it is evident that the 0- to 1-inch layer of all grazed areas is much more compact than the 1- to 3-inch or the 3- to 6-inch layers even though it is much higher in organic matter. Runoff losses appear to be related to the volume weight of the 0- to 1-inch layer and also to the amount of vegetative cover.

From these preliminary trials it would appear that runoff from closely grazed pastures during storms of high rainfall intensities that frequently occur during midsummer is an additional factor contributing to low-pasture production during this season of the year.

PART II

RESEARCH AT THE LABORATORY

CYTOGENETICS AND BREEDING

Fertility Studies in Dactylis glomerata

Except for additional plantings little progress was made in the male sterility study (1945 Annual Report, page 35). About 9100 seedlings from various crosses were set out in the plant nursery in the spring of 1946. In addition over 900 plants involved in the study (1945 Annual Report, page 36) of the effect of inbreeding upon irregularity of meiotic behavior and fertility were established in the nursery.

Varietal Improvement in Dactylis glomerata,
Poa pratensis, Bromus inermis,
and Trifolium repens

Inbreeding in Orchard Grass. Seedlings from selected self-pollinated plants (1944 Annual Report, page 31) were planted in the nursery in the spring of 1946, as follows: 51 I₁, 12 I₂, 10 I₃, 4 F₄, and 6 I₅. This material will be studied to observe the effects of inbreeding.

Open-pollinated seed was harvested from each of the 60 I₄ lines from 17 families and the original parental clones which had been planted as a replicated polycross in 1945 (1944 Annual Report, page 31, 1945 Annual Report, page 36). This seed is to be used to test the effects of four generations of inbreeding on combining ability. Bagged seed from these I₄ and some I₃ plants was obtained to continue the study.

Hybridization and Recombination of Characters in Orchard Grass. F₁ plants from crosses of 25 selected clones of orchard grass (1945 Annual Report, page 37) were brought into the greenhouse from the nursery in the fall. Segregating progenies from sibmating among these plants will be selected for favorable combination of desired characters.

Comparison of Clonal and Polycross Progeny Tests for Evaluation of Individual Plants of Dactylis glomerata and Trifolium repens. Green weights were obtained of clippings from the plots established in the spring of 1945 to test the validity of using clonal material for the evaluation of plants in the breeding program (1945 Annual Report, page 37). In orchard grass analyses of variance showed significant F values for method of planting in the first and third clippings and some significance for the fourth, significance for difference among the polycross clones in the second and fourth clippings and some significance in the third. An analysis for the total green weights,

however, showed no significant F values for differences. These inconsistencies may be attributed in part to the differences in yield of clonal and seeded plots as the season advanced, the seeded plots yielding more in the first two harvests and less than the clonal plots in the third and fourth. In general, rank of yield of clonal and seeded plantings did not agree from one harvest date to another or for the entire season. Analyses made for the yields from the plots of Ladino clover showed some significance for the differences in method of planting in the second and third and significance for the fourth and total of all harvests. The red clover volunteers in the clonally planted plots, a probable factor in the current lack of significance of differences between the clones, may be expected to be eliminated in the coming year.

Reaction of Varieties of Orchard Grass to Systems of Management and Associated Legume Species. Treatment differentials of plots established in 1945 (1945 Annual Report, page 38) were started in the spring of 1946 and yield data were taken at each harvest date throughout the season. Since a stand of the legume was not obtained in the orchard grass-alfalfa series, these plots were used to study the responses of the various varieties of orchard grass to nitrogen fertilization. Two applications were made of nitrogen at 40 pounds per acre, one following the removal of the first cutting and the other following the removal of the second cutting. The orchard grass-Ladino series was not altered. The plots in which the herbage was mowed to three inches when it had reached 8 to 10 inches were harvested three times and those in which the first crop was harvested at the early head stage were later mowed but once more.

Analyses of the yields for the first year after establishment indicate statistically significant differences between strains, management treatments, and some of the interactions of these variables. Inasmuch as the plots had not become fully established until nearly midsummer of 1946, definite conclusions regarding these results may not be warranted. It may be interesting to note that the plots seeded to the commercial seed lot and those seeded to Brage yielded slightly more than the average of all plots, while Hercules and Finnish Late Hay were slightly below the average. There was also an indication that Ladino clover persisted better with some strains of orchard grass than with others. The yield of Ladino clover was greatest in association with State College Isolation 1942, No. 1 and least with the lot of commercial seed.

Response of Strains of *Poa pratensis* to Nitrogen Fertilization and Height of Clipping. Studies were continued of the series of plots of eight strains of Kentucky bluegrass arranged to provide for two heights of clipping and differential nitrogen fertilization (1943 Annual Report, page 26; 1945 Annual Report, page 41). Yield data obtained from the plots indicated strain differences in the "high nitrogen" plots, which had very high percentages of bluegrass, but any strain differences in the "no nitrogen" plots were masked by an excellent stand of clover. The "high nitrogen" plots ranged in yield (average for eight plots) from 6,334 pounds per acre for strain 176(22) to 8,379 for strain

114(12); the "no nitrogen" plots ranged from 4,958 pounds per acre for strain 176(22) to 5,611 for strain 143(223), but these latter differences were not statistically significant. For the eight strains, total yields of all plots, both high nitrogen and no nitrogen, ranged from an average per plot of 5,646 pounds per acre for strain 176(22) to 6,950 for strain 143(223). Statistical treatment of the total yields showed significant differences for strains, height of clipping and nitrogen application and for a number of interactions. Botanical separations of samples of herbage harvested from the "no nitrogen" plots in June were analyzed for calculated percentage of grass, clover, and weeds. All these showed significant differences between strains and the percentage of grass showed significant differences for heights of clipping.

Production of Improved Strains of *Bromus inermis*. In addition to the 173 clones selected for a polycross test (1945 Annual Report, page 42) 134 clones from the same original nursery were increased vegetatively and established in the spring of 1946 for the production of polycross seed. In the fall another group of 29 clones selected from another source were increased and planted for a third polycross test. It is expected that seed will be harvested during the summer of 1947 from selected clones among the 173 established in the first test.

Inbreeding in *Trifolium repens*. From the selfing of 45 I₃ and I₄ white clover lines in the summer of 1945 (1945 Annual Report, page 42) 35 produced enough seed to permit the establishment of a polycross test of these lines. In the spring of 1946 the progeny of each of the 35 selfed lines was randomized in a 10-replication polycross block. Open-pollinated seed to be harvested from these plants in the summer of 1947 will be used as a test of these lines.

Progenies of the 38 I₂ self-fertile white clover lines subjected to selfing in the summer of 1945 (1945 Annual Report, page 43) were planted in the field in the spring of 1946. These I₃ lines will be selfed in the summer of 1947.

Genetic Investigations

Heritable Young Plant Characters in *Dactylis glomerata*. In continuation of studies of inheritance of young plant characters in orchard grass (1945 Annual Report, page 43) 6,143 F₂ seedlings were planted in flats during the fall of 1946 and classified for seedling characters such as yellow virescent, albino, etc. The data have not yet been analyzed. During the year approximately 1400 plants involving mutant seedling characters were established for genetic studies in the nursery.

Inheritance of Flower Color in *Medicago sativa*. Eighty F₁ plants and the parents involving 15 alfalfa clones were brought into the greenhouse for the production of F₂ and backcross seed. Flower colors represented in these crosses range from light to dark blues and purples and include whites and yellows.

Size Inheritance in *Trifolium repens*. During the summer of 1946 measurements of size characteristics were made on plants of the various generations--the Ladino and wild white clover parental clones, the F_1 clone, the F_2 generation obtained from selfed seed of the F_1 clone, and backcrosses of F_1 with each original parent--in each of five of the nine series of plants set out in the field in the spring of 1945 (1945 Annual Report, page 43). Also measured was the new F_1 population from crosses between the two parents made in the greenhouse in the winter of 1944-45. This program involved approximately 1600 plants. Measurements taken on these plants consisted of length and width of terminal leaflet and length and width of petiole on the second fully opened leaf from the tip of a stolon. Area of terminal leaflet was calculated from length and width of leaflet ($\frac{\text{length} \times \text{width}}{2}$). Five leaves per plant were measured. Summaries and analyses of the data obtained are in process. The summary of means for the first series measured in Table 4 gives some indication that the genetic mechanism of size inheritance in Ladino-white clover crosses may be some type of multiple-factor interaction with the possible dominance of large size.

Mainly because of the disturbing variability, especially within clones, as evidenced in the field data, there were set up in the greenhouse for the winter of 1946-47 three randomized and replicated experiments which should probably give a more critical evaluation of the true genetic size differences existing within and between the segregating and parental generations than could be expected from the field material. The largest of these experiments consists of 95 F_2 plants of one of the series--the first series measured in the summer of 1946. These plants were selected to represent the whole range of the size distribution for the F_2 population of that series. Clonal isolates from each plant were randomized in three replications, and randomized with them were the two original parents and the F_1 clone. The other two greenhouse setups were 3-replicate, randomized experiments involving (1) 30 backcross plants of the same series as the F_2 clones in the above-mentioned study and (2) 50 new F_1 's from the population mentioned in the first paragraph of this size inheritance report. Leaf, stolon, and flower size measurements will be taken on these plants, and the F_2 plants will be selfed to obtain F_3 seed.

Material of four generations--parental, F_1 , F_2 , and F_3 --will then be available for field planting in the spring of 1947.

Inheritance of Leaf Markings in *Trifolium repens*. The F_1 progenies of crosses of 18 different combinations of the various leaf patterns (1945 Annual Report, page 44) were intercrossed and backcrossed to the parents in the greenhouse during the winter of 1946. Approximately 800 crosses were made.

The progenies of these backcrosses and intercrosses are being grown and classified for leaf-marking patterns in the greenhouse during the winter of 1946-47. Also being classified for this character are progenies of self-fertile plants grown and selfed in the field during the summer of 1945.

Table 4. Leaf and petiole measurements of plants from Ladino-white clover crosses in series 1.

Generation	Number: of plants:	Terminal leaflet (second fully opened leaf)			Length of petiole (cm.)	Width of petiole (micrometer units)
		Length (mm.)	Width (mm.)	Area (sq.mm.)		
Parents						
Ladino clover	30	28.7 ± 3.6	22.4 ± 2.5	330 ± 75	9.4 ± 1.8	6.57 ± 0.41
Wild white clover	31	16.6 ± 2.2	12.7 ± 1.9	108 ± 30	6.1 ± 1.2	4.17 ± 0.37
F ₁	30	24.7 ± 3.1	18.7 ± 2.3	238 ± 58	7.8 ± 1.75	5.72 ± 0.50
F ₂	147	20.3 ± 4.1	15.7 ± 3.1	167 ± 66	6.5 ± 1.9	5.25 ± 0.68
Backcrosses						
Ladino x F ₁	51	26.4 ± 4.1	19.7 ± 3.0	268 ± 77	8.1 ± 2.35	6.15 ± 0.67
Wild white x F ₁	48	21.1 ± 4.5	16.4 ± 3.1	181 ± 74	7.1 ± 2.4	4.87 ± 0.55

Still in need of genotypic testing are the F_1 progenies of 28 different crosses among the leaf pattern types. These crosses, largely between the F_1 and the homozygous recessive unmarked type, will be made in the winter of 1947.

Classifications were made on various lots of commercial Ladino and other white clover plants to ascertain the frequency of the various leaf markings in natural populations. From a total of 2400 plants, the following is the frequency, in percent, of the various markings:

1. No marking - 9.0.
2. Single V - 72.0.
3. Double V - 4.5.
4. V-point - 5.0.
5. Broken V - 2.9.
6. Broken V and yellow point - 0.9.
7. Full and broken V - 4.0.
8. Full and broken V, with yellow point - 1.0.
9. V-point and broken V - 0.3.
10. V with white inside - 0.4.

Cytological Investigations

Origin of Aneuploidy in *Dactylis glomerata*. Chromosome numbers were determined from root tip preparations of seedlings from open-pollinated plants which had shown some irregularity of meiosis (1945 Annual Report, page 45). Ten further plants were found to have 29 chromosomes. Many of the 29-chromosome plants determined in the past two years were used as parents in crosses with 28-, 29-, 30-, and 31-chromosome plants made to obtain a series of trisomic plants.

Chromosome numbers of 98 plants from backcrosses of 35-chromosome to normal 28-chromosome plants (1945 Annual Report, page 46) are being determined from root-tip preparations. Preliminary counts show a range in chromosome number from euploid 28 to aneuploid 35 with 29 most frequent. This series of plants may also be a source of trisomics as well as of other aneuploid plants.

Effect of Heat Treatment on Meiotic Irregularity in *Dactylis glomerata*. A study of the effects of heat treatment upon meiotic irregularity was started in the spring of 1946. Four series, consisting of four temperature treatments (37°, 34°, 31°, and 24° C.) at four different intervals (24 hours, 8 hours, 4 hours, and 2 hours) were run in the temperature control chambers. Air temperature and humidity were automatically recorded. Collections for meiotic study were made at intervals of one to four days after treatment. The data are being analyzed at the present time and irregularities in meiotic behavior are appearing especially at the higher temperature. These irregularities are evidenced particularly by the large number of univalents present at metaphase I.

Colchicine Induced Autotetraploidy in Dactylis aschersoniana. Vegetative increases for purification of clones showing chromosome doubling are in progress. Three pairs of diploid and tetraploid clones obtained from previous treatments (1944 Annual Report, page 40) were induced to flower in the greenhouse. This material is being analyzed cytologically and was used for tests of cross-compatibility with normal D. glomerata. Plants from reciprocal crosses between the tetraploid clones of D. aschersoniana and D. glomerata were grown in the nursery during the past summer and some of them judged to be hybrids by pubescence of glumes have been brought into the greenhouse for meiotic study and use in further crosses. Thirty-six plants from crosses between the diploid and tetraploid clones of D. aschersoniana and between diploid D. aschersoniana and D. glomerata were brought into the greenhouse for chromosome determination. No triploid plants, 21 chromosomes, were found among these. Further crosses are to be made in the hope of obtaining some triploids.

Colchicine-treated seed from plants of a diploid species of Dactylis from Iran (1945 Annual Report, page 46) produced plants which were checked for chromosome number. Some of them which showed indications of doubling have been propagated vegetatively in the hope of obtaining purified clones of tetraploid plants. When these are established they will be crossed with tetraploid clones of D. aschersoniana and the progeny compared cytologically and morphologically with D. glomerata. Crosses of diploid plants of the Iranian species of Dactylis and D. aschersoniana produced seed in the greenhouse. Plants of these crosses are growing in the greenhouse for the production of seed which may be treated with colchicine. This procedure may provide a second possibility of securing a synthetic species of Dactylis for comparison with D. glomerata.

Chromosome Numbers in Bromus inermis. Work on determination of chromosome number of each of the 173 selected plants included in the polycross plot (1945 Annual Report, page 42) is being continued. With the exception of seven plants as yet undetermined, all but one appear to be octoploid ($2n = 56$). This one plant had 56 chromosomes plus a variable number of fragments in root tip cells. Several other plants from the same seed source are growing in the greenhouse preliminary to chromosome number determination. A series of plants from seed of reputed 42-chromosome plants are growing in the greenhouse for determination of chromosome number.

PATHOLOGY

Studies on Crown Rust (Puccinia coronata) of Festuca and Lolium

The plants of Festuca elatior immune to crown rust previously tested (1945 Annual Report, page 48) were observed another season in comparison with susceptible material. The rust-immune plants were inoculated with composite samples of urediospores that infected plants in the

vicinity of State College. No infection was observed on any of the rust-immune plants. During the present winter the rust-immune plants are being increased for establishing a field nursery and for distribution for further testing elsewhere.

Studies on cross-infection of crown rust from meadow fescue and perennial ryegrass are in progress.

A manuscript on the crown rust studies involving F. elatior and F. elatior var. arundinacea was prepared and submitted for publication (page 74).

Diseases of Dactylis spp.

In order to facilitate selecting disease-resistant plants of orchard grass, a small nursery was established in which 10 of the most promising clones were replicated six times. Clones susceptible to stem rust, Stagonospora leaf spot, and Rynchosporium leaf blotch were distributed at random throughout the nursery to provide inoculum for natural infections. Provision was made so additional promising clones could be added from time to time. In this manner, clones can be kept under almost continuous observation for resistance to some of the most prevalent diseases.

Additional work on inoculating Dactylis aschersoniana and its polyploids with Stagonospora are being held in abeyance until sufficient material is available for study. Cultural studies of the organism will be resumed when suitable material can be collected outside the vicinity of State College.

Alfalfa Wilt

Investigations previously initiated (1945 Annual Report, page 51) were continued. During the spring and fall fresh cultures of the causal organism were isolated from collections of diseased plants obtained in the vicinity of State College and from the large commercial alfalfa-growing areas of Eastern Pennsylvania. Fresh isolates were compared culturally with isolates obtained 1 and 2 years earlier. Aside from some differences in intensity of the blue pigment on lactose agar, no striking differences between isolates were obtained.

Cultures of wilt bacteria were stored for one year or more in nutrient-dextrose broth at room temperature and at 15° C. to determine whether variants would arise in old broth cultures. Colonies obtained from the 16 cultures tested at room temperature were principally smooth with no R types observed. Of 43 cultures stored at 15° C. colonies were obtained from 39. Aside from differences in pigmentation no aberrant colony forms were observed. This suggests that Corynebacterium insidiosum is a fairly stable organism.

Sclerotinia trifoliorum as a Factor in
Winter Injury of Trifolium repens

In the spring of 1944 some winter injury apparently caused by Sclerotinia was observed in Ladino and white clovers at State College, Pennsylvania. In the spring of 1945 and again in 1946 extensive killing was observed in both small and large areas of Ladino clover. Numerous sclerotia were secured either attached to destroyed stolons or lying in the soil surrounding partially disintegrated stolons. In some cases, damaged stolons had cottony tufts of mycelium where sclerotia were forming and occasionally matured or partially matured sclerotia were found imbedded within damaged stolons. Numerous sclerotia were obtained from areas where extensive killing occurred and cultures were obtained from them.

During October and November of 1946 numerous apothecia of Sclerotinia trifoliorum were found emerging from sclerotia where earlier damage to clovers had occurred. Single-ascospore cultures were obtained from mature apothecia for further study. To date, 86 single-ascospore isolates from white clover and 22 single ascospore isolates from red clover have been grown on potato-dextrose agar and several cultural strains differentiated.

It is hoped that pathogenicity of at least some of the isolates can be tested during the winter months. To this end, 28 single-ascospore isolates have been selected as representative of isolates obtained thus far. They are being cultured in a wheat-oats mixture for the pathogenicity tests.

Since control of microorganisms frequently depends upon breaking the weakest link in the life cycle, efforts were made to induce formation of apothecia under controlled conditions. As a preliminary study, sclerotia were incubated at 24 different time-temperature schedules. Formation of apothecial fundaments was achieved but none of the fundaments expanded to form apothecial cups.

Preliminary field inoculations of Ladino clover were carried out in the fall of 1946 with inoculum prepared by compositing several isolates. A number of spaced plants of Ladino clover known to be susceptible or resistant to winter injury were inoculated in the field. Similarly, two strips of Ladino clover, approximately 50 feet long by 2 feet wide, were inoculated and uninoculated check strips left on either side. Examination of inoculated plants at intervals for several weeks following inoculation revealed that leaves and petioles were killed within a few days. Some infection of the terminal buds of stolons was observed but the extent of infection and consequent damage cannot be determined until the spring and summer of 1947.

Extensive inoculation tests under controlled conditions in both the greenhouse and the environmental control chambers are contemplated for later in the winter.

Virus Diseases of Trifolium repens

Observation of spaced plants in the field the past two years has indicated that virus diseases of Ladino clover are potentially serious. Many of the selected plants brought into the greenhouse for crossing this winter were discovered to be infected. Susceptible plants selected for study of viruses strongly indicate that several virus strains or different viruses are involved. Infected plants of Ladino clover with unusual symptoms are being segregated and tested to determine transmissibility of possible new viruses. If transmission is established from clover to clover either by mechanical inoculation or by stolon grafts further screening of the virus or virus complex will be attempted by mechanical inoculation to related and unrelated hosts.

A striking disorder of Ladino clover has recently been shown to be of virus origin. The disease was noticed in scattered areas in fields of Ladino the past several years but was not prominent enough to be considered destructive. In the spring of 1946, a 10-acre field of Ladino clover was observed in Northern New Jersey where an estimated 75 percent of the plants displayed symptoms of the disorder. Leaves on most plants had interveinal blotches of bright yellow which contrasted sharply with deep green areas of healthy tissue. In some cases only small blotches occurred on isolated leaves but in others almost the entire leaf was yellowed. Leaves that were severely affected were frequently distorted and failed to survive. Many affected plants showed abnormal growth and failed to produce stolons of any length.

Plants displaying symptoms of the disorder were found in some of the plots at State College. The disorder was readily transmitted to healthy, mature Ladino clover plants by stolon grafts. Mechanical transmission of the disorder from Ladino clover to Ladino clover was achieved but with more difficulty. The disorder was transmitted to four varieties of peas where symptoms were differentiated from common clover mosaic by appearance of line patterns and chlorotic ring spots on lower leaves.

Further tests are necessary before the virus can be identified positively but preliminary results suggest that it may be similar to a virus recently described on white clover in Kentucky.

Red Clover Observation Nursery

A new nursery with 12 strains of red clover replicated three times was sown in the spring of 1946. Notes on prevalence of diseases and relative susceptibility to them were taken on red clover strains in the 1944 and 1945 nurseries.

Since the winter of 1945-46 was rather open with little snow cover, the ground was extremely dry in early spring. Many plants in the 1944 nursery had died. Examination of dead and dying plants revealed many attacked by Sclerotinia trifoliorum. Abundant sclerotia were found on

lateral roots and below the crowns of dead plants. Another factor involved in death of plants was extensive root borer injuries that lead to secondary infection and winterkilling. Considerable heaving also occurred which undoubtedly killed a number of plants. Only one plant definitely infected by Sclerotinia was found in the 1945 red clover nursery. In general, the plants survived the winter in good shape with minimum killing.

Observation of both the 1944 and 1945 nurseries during the summer and fall revealed that northern anthracnose (Kabatella caulivora) was invading the plots but was not yet severe enough to cause serious damage.

A russetting of leaves previously found only among plants of the Tennessee strain of red clover was found generally distributed among plants of all strains during early June 1946. The cause of the abnormality has not been established but it may be a virus disease. Damage from the disorder is potentially serious since affected leaves are frequently distorted and die much earlier than healthy leaves.

In three years of tests, the Wisconsin mildew-resistant strain has stayed free of this disease. However, the strain fails to become established readily and stand survival after the first year is low.

Table 5 presents a summary comparing stand survival and recovery following clipping of the strains under test during the year following establishment. Results to date indicate that the Kentucky selection is equal in stand survival to the best Pennsylvania selections and superior to all in recovery following clipping. This strain also is superior to the commercial strains Cumberland and Midland, ordinarily grown in the Northeastern States.

Influence of Spergon on Germination of Trifolium spp.

Continuing the investigations reported earlier (1945 Annual Report, page 53) it was found that germination of strawberry clover (Trifolium fragiferum) in both steamed soil and Petri dishes was greatly reduced by each of the 12 lots of Spergon tested. The six lots of strawberry clover tested responded similarly to the fungicide. Further work is contemplated to determine how extensive injurious response to treatment with Spergon may be among forage legume seeds.

Table 5.. Comparison of strains of red clover in disease nurseries with respect to stand survival and recovery following clipping.

Grouping/ ¹	1944		1945		1946	
	Stand survival	Recovery after clipping	Stand survival	Recovery after clipping	Stand	
1	P.S.C. ² /Kunkle	Kentucky	P.S.C. Wilson	Kentucky	P.S.C. Scott	
	P.S.C. Bashore		P.S.C. Ferguson		P.S.C. Bashore	
			P.S.C. McCleary		Kentucky	
			Dollard			
			Kentucky			
			Midland			
2	P.S.C. Scott	P.S.C. Bashore	Cumberland	P.S.C. Wilson	Cumberland	
	Kentucky	P.S.C. Scott	P.S.C. Seager	P.S.C. Ferguson	P.S.C. Kunkle	
	Midland	Midland	Ottawa	P.S.C. McCleary	New Hampshire	
	New Hampshire			Midland	Dollard	
	Dollard					
3	Wisconsin	Cumberland	Wisconsin	Dollard	P.S.C. Hill	
	Cumberland	New Hampshire		Wisconsin	Ottawa	
		Dollard		Cumberland	Wisconsin	
		Wisconsin			Midland	
4	P.S.C. Shelley	P.S.C. Kunkle	Tennessee	P.S.C. Scager	P.S.C. Shelley	
	Ottawa	P.S.C. Shelley		Ottawa		
	Tennessee	Ottawa		Tennessee		
		Tennessee				

¹ P.S.C. = Pennsylvania State College selections.

² 1 = best, 4 = poorest.

PHYSIOLOGY AND COMPOSITION OF PASTURE PLANTS

Photoperiodic Responses of Several Pasture Species

Studies on the effects of short intervals of light during the normal winter night on head formation (1945 Annual Report, page 54) were continued in 1946. Four clones of orchard grass and one clone each of bromegrass and Canada bluegrass were started and grown for about 2-1/2 months under the short fall and early winter day lengths before being subjected to the various light treatments. These treatments included (a) natural day (9-1/2 to 10-1/2 hours), (b) 12-hour day, (c) 16-hour day, and (d) natural day plus various amounts of supplementary light supplied during the middle of the dark period. These latter light periods consisted of 1-hour, 1/2-hour, 1/4-hour, and 1/16-hour intervals of light. All supplementary light, whether used to increase the length of the normal day or to provide light during the middle of the normal dark period, was supplied by Mazda lamps at an intensity of approximately 75 foot candles at the surface of the soil in the pots.

No heading of any of the plants occurred under the natural or 12-hour day lengths. In orchard grass the largest number of heads and the shortest time to flowering were obtained under the 16-hour day. One hour of light at midnight produced slightly fewer heads per pot and increased the number of days required for flowering. As the length of the light interval at night was decreased further, the length of time to flowering increased but the number of heads produced remained about constant. The bromegrass clone behaved like the orchard grass except that no heads were produced when the light interval was less than 1/4 hour. The Canada bluegrass clone produced as many heads under 1 hour and 1/2 hour at midnight as under the 16-hour day, but with shorter light intervals the number of heads initiated decreased. The results of the 1945-46 trials support the previous years' experiments wherein short intervals of light during the middle of the normal dark period are effective in initiating head formation of orchard grass, bromegrass and Canada bluegrass.

The Responses of *Dactylis glomerata*-*Trifolium repens* and *Bromus inermis*-*T. repens* to Nitrogen Fertilization and Height and Frequency of Cutting

Studies on the time and height of clipping orchard grass-Ladino clover and bromegrass-Ladino clover as they relate to yield and the persistence of the legume (1944 Annual Report, page 46, and 1945 Annual Report, page 55) were continued during 1946. On these plots, as on other fields in this vicinity, winterkilling of Ladino clover was serious during the winter or spring of 1945-46. Those plots which received the more favorable treatments, i.e., removal of the first crop before competition from the grass was a serious factor, contained and maintained the larger amounts of clover (Table 6). Rainfall throughout the 1946 season was generally favorable yet the

Ladino clover content of the plots decreased more than the normal during midsummer and did not recover as well during the fall. Inspection of these plots revealed considerable Sclerotinia present. Whether this disease was the main cause for the decrease in clover and its limited recovery in the fall was not determined but it appeared to be an important factor.

Table 6. The effect of stage of growth and nitrogen on yield of orchard grass-Ladino clover and brome grass-Ladino clover during 1946.

Clipping treatment	: Total : Pounds per acre oven-dry weight			
	: number :			
	: of : Ladino :			
	: cuttings: clover : Grass : Total			
	: Orchard grass - Ladino clover			
Approx. 10" to 2"	: 5	: 446	: 3912	: 4358
Approx. 10" to 2" + N	: 5	: 285	: 4654	: 4939
Early head to 1"	: 4	: 301	: 4445	: 4746
Early head to 1" + N	: 4	: 120	: 5174	: 5294
Late head to 1"	: 4	: 106	: 5423	: 5529
Late head to 1" + N	: 4	: 41	: 6324	: 6365
	: :	: :	: :	: :
	: Brome grass - Ladino clover			
Approx. 10" to 2"	: 5	: 757	: 3895	: 4652
Approx. 10" to 2" + N	: 5	: 584	: 5091	: 5675
Early head to 1"	: 3	: 437	: 6051	: 6488
Early head to 1" + N	: 3	: 116	: 7303	: 7419
Late head to 1"	: 3	: 208	: 5743	: 5951
Late head to 1" + N	: 3	: 17	: 7766	: 7783
	: :	: :	: :	: :

The responses of the brome grass-Ladino clover plots to clipping indicated that under a management of early clipping to maintain the clover, the brome grass was so weakened that volunteer Kentucky bluegrass was becoming established (Table 7). This was particularly evident under the treatments in which the herbage was removed whenever it had attained a height of 5 to 6 inches and under those plots harvested when the herbage was 8 to 10 inches tall.

As in previous years (1944 and 1945 Annual Reports) nitrogen fertilization increased the yields of clover on the plots to which it was applied. In 1946 as in previous years, the greatest yields of Ladino clover were obtained under cutting treatments which reduced the competition of the grass.

Table 7. Species composing the herbage harvested in June 1946 from plots of a brome-grass-Ladino association subjected to various cutting and fertility treatments from 1944 to 1946, inclusive.

Treatment	Percent by weight of harvested herbage		
	Ladino	Kentucky bluegrass	Brome-grass
5" to 1"	30	25	38
10" to 1"	26	12	56
10" to 2"	18	17	63
10" to 2" + N	13	21	64
10" to 3"	11	15	73
Early head to 1"	9	11	79
Early head to 1" + N	2	12	86
Early head to 3"	5	16	79
Late head to 1"	1	2	97
Late head to 1" + N	trace	0.3	99
Late head to 3"	1	0.4	98

Persistence of Trifolium repens var. latum
in Broadcast vs. Drilled Seedings of Grasses

In 1944, small plots of orchard grass and of brome-grass were seeded broadcast and in rows 14 inches apart. Ladino clover was seeded uniformly over the entire area. Different levels of nitrogen fertilization were used in the experiment. The herbage was harvested 2 or 3 times per year. Confining the grass to rows 14 inches apart has been no more effective than broadcast seeding in maintaining clover. In fact during the summer of 1946 more Ladino clover stolons survived within the grass rows than between the rows.

Fall vs. Spring Applications of
Nitrogen to Dactylis glomerata

Results this year show that ammonium sulphate applied at rates to give 30, 60, and 120 pounds per acre of nitrogen was more effective when applied on March 27, 1946, than when applied November 1, 1945. The spring applications gave both higher yields of dry matter and higher nitrogen contents in the grass (Table 8). The calculated nitrogen recovery ranged from 14 to 26 percent for the fall applications of nitrogen as compared with 39 to 45 percent for the spring applications.

Table 8. Yields of dry matter and recovery of nitrogen from fall vs. spring applications of ammonium nitrate to orchard grass.

Nitrogen : applied . pounds : per acre :	Time : of : appli- cation :	Yields of : dry matter : pounds : per acre* :	:	Nitrogen : content : (percent) :	:	Total : nitrogen : pounds : per acre :	:	Nitrogen : recovery : (percent) :
None	:	:	:	:	:	:	:	:
30	: -	: 3668	:	: 1.29	:	: 47.3	:	: -
69	: 11/1/45	: 4333	:	: 1.19	:	: 51.4	:	: 14
120	: "	: 4843	:	: 1.28	:	: 61.8	:	: 24
30	: "	: 5189	:	: 1.52	:	: 79.0	:	: 26
60	: 3/27/46	: 4643	:	: 1.31	:	: 60.9	:	: 45
120	: "	: 5129	:	: 1.38	:	: 70.7	:	: 39
	: "	: 5700	:	: 1.78	:	: 101.3	:	: 45
:	:	:	:	:	:	:	:	:

* First cutting only (June 10, 1946). No additional recovery of nitrogen was obtained in subsequent cuttings.

Responses to Nitrogen Fertilization,
Irrigation and Clipping Treatments on
a Poa pratensis-Trifolium repens sod

Data were obtained for the third year on the response of a Kentucky bluegrass-clover sod to nitrogen fertilization, irrigation and clipping treatments (1944 Annual Report, page 49, and 1945 Annual Report, page 56).

In 1945 excellent stands of white clover (predominantly the larger types) were present on all plots except where fertilization and management were unfavorable for clover. During the winter of 1945-46 much of the clover was lost even though 100 pounds of P_2O_5 and 150 pounds of K_2O were applied in the fall and an adequate lime level had been maintained. In fact less clover survived than on a narrow check strip that received no potash.

Under frequent clipping little opportunity is afforded for reseeding of clover as compared with that under grazing. Therefore a broadcast seeding of 2 pounds per acre of Ladino clover and 2 pounds of white clover was made to all plots in March of this year. The rapidity of reestablishment of clover varied considerably depending on the treatment, but by the end of the season good stands of clover were present on all plots that received no nitrogen fertilizer and even on certain of the high nitrogen plots.

Yields of dry herbage under different nitrogen, moisture, and clipping treatments are shown in Table 9. The increases in yield from irrigation were relatively small considering that a total of 8.2 inches of water

was applied to the irrigated series. One reason for this small increase was that in general periods of dry weather were of short duration. In a number of cases irrigation was followed within a few days by rainfall. As in previous years irrigation resulted in excellent growth during midsummer.

Table 9. The effects of nitrogen fertilization, irrigation, and clipping treatments on the yields of a Kentucky bluegrass-clover sod.

Clipping treatment	Yields of dry matter pounds per acre			
	Not irrigated		Irrigated	
	No	High*	No	High*
	nitrogen	nitrogen	nitrogen	nitrogen
Cut to 1/2" when 4"	4981	7443	5242	7869
Cut to 1" when 4 to 5"	4580	6454	4954	7676
Cut to 2" when 5"	3639	5285	3919	7033
Cut to 1/2" when 3" in early spring; then to 1" when 4 to 5"	5235	6936	5043	8063
	:	:	:	:

* Forty pounds per acre of nitrogen in the early spring and repeated after each clipping.

In all cases clipping to a height of 2 inches gave lower yields than more severe clipping treatments. This is in agreement with results obtained in previous years. At the low nitrogen levels this is attributed in part to a nitrogen deficiency resulting from relatively lower clover populations. Yet, even when nitrogen was maintained at a high level by applying 40 pounds of nitrogen after each clipping, yields were lower on plots clipped to 2 inches than on those clipped to 1 inch or 1/2 inch. On the other hand, plots clipped to 2 inches had a more dense sod of grass with fewer weeds.

Samples of rhizomes and of stubble were taken from the high nitrogen (40 pounds of nitrogen after each clipping) irrigated plots at two dates in the late fall and analyzed for soluble carbohydrates. On the plots clipped to two inches the rhizomes averaged 21.9 percent soluble carbohydrates on October 24 and 33.5 percent on November 26. On plots clipped to 1/2 inch the values were 25.8 and 34.3, respectively. Thus soluble carbohydrates increased considerably from late October to late November. The higher soluble carbohydrates in October from grass clipped to 1/2 inch than from grass clipped to two inches probably can be explained on the basis of cutting dates. The last clipping for the year was on October 3 on the 1/2-inch series while the 2-inch series was cut on October 16. Thus the latter had less time to recover following clipping. Percentages of soluble carbohydrates in the stubble closely paralleled those in the rhizomes.

For certain treatments grass, clover, and weeds were separated at each clipping date and the grass analyzed for total nitrogen content. Without nitrogen fertilization and on plots clipped to one inch the nitrogen content of the grass ranged from 2.6 percent to 4.2 percent. In the late fall of 1945 values as high as 4.7 percent were obtained. These differences were associated with differences in clover population. The range on irrigated and nonirrigated plots was similar. With irrigation and nitrogen fertilization at the rate of 40 pounds of nitrogen per acre after each cutting, the nitrogen content averaged slightly over 4.0 percent but varied considerably (3.9 percent to 4.8 percent) depending upon the total yields of dry matter.

Nitrogen determinations were completed on samples of herbage collected during 1944 and 1945. Since clover was abundant in 1945 and present in small amounts during 1944 the response to nitrogen was entirely different during the two years. Excellent responses to nitrogen were obtained in 1944. In 1945 nonirrigated plots that received no nitrogen fertilizer produced herbage higher in percentage nitrogen content than plots that received 40 pounds of nitrogen in the early spring and again after each cutting except the last one in the fall (240 pounds for the year). The nitrogen-treated plots averaged slightly higher in yield of dry matter, however, so that the yield of protein (not yet calculated) was not greatly different.

Phosphate Placement Studies

Data from plots of orchard grass-Ladino clover established in 1944 on Dunmore silt loam (1945 Annual Report, page 61) still show that phosphate in bands 14 inches apart and 2 inches below the soil surface was no more effective than phosphate broadcast and worked into the soil. The phosphate was applied at rates of 50, 100 and 200 pounds of P_2O_5 per acre. All plots received lime and potash.

The Response of Various Forage Grasses and Legumes to Phosphate Fertilization

Field plots of pure species established in 1944 continue to show that alfalfa and Ladino clover require higher levels of available phosphate for satisfactory growth than do birdsfoot trefoil and any of the more commonly grown forage grasses (1945 Annual Report, page 59).

Reserve Studies on Grasses

Chemical analyses have been completed on perennial ryegrass plants which had been subjected to four temperature conditions during the recovery period following defoliation (1943 Annual Report, page 52, and 1945 Annual Report, page 62). At the end of 40 days' growth under the artificial conditions of the experiment, the average weight of an entire plant was less than that of the defoliated plant at the beginning of the

period. Losses of stored material in the stubble and roots were partially accounted for by new top growth and partially by respiration. New top growth was greatest at a daily temperature range of 60 to 70° than at higher or lower temperatures. Respiration was greater at higher temperatures, the losses of dry matter in the stubble being greatest at 70 to 80° and in the roots at 80 to 90°. In spite of the considerably greater loss of carbohydrate reserves at the highest temperatures little top growth resulted. The losses in the stubble and roots were in sugars and fructosan. All of these constituents reached a low percentage about midway in the period of the experiment, after which restorage occurred to some extent at the lower but not at the higher temperatures. By 40 days, however, none of the plants had regained the content of carbohydrate reserves present at the beginning. Other constituents were either not lost or small losses were masked by carbohydrate changes. Increases on a percentage basis occurred in cellulose, lignin, non-fermentable sugars derived from polysaccharides, total nitrogen, calcium, and phosphorus, and, with few exceptions, the increases were greater when the soluble carbohydrates showed the greater losses, namely, at the high temperatures. Proteins were apparently hydrolyzed, the soluble nitrogen of the stubble at the highest temperature reaching over 30 percent of the total.

SUMMARY

Cytogenetics and Breeding

In the absence of the project leader for part of the year, the data collected on the more fundamental aspects of orchard grass breeding were not completely analyzed. For the male sterility and inbreeding studies a total of some 10,000 seedlings was established in the nursery. Inbreeding has now proceeded to the I₆ generation in a few lines. Seed was harvested to be used in making plantings to test the effects of four generations of inbreeding on combining ability.

In a comparison of green weights of clonal and polycross progenies of orchard grass grown in association with Ladino clover, relative rank in yield between the two methods of planting agreed neither at any one harvest date nor for the entire season. Similar results were obtained from an analogous test using Ladino clonal and polycross progenies associated with a bulk seeding of orchard grass. These results are for one year only and the plots are not yet well enough established to justify drawing definite conclusions.

In yield tests to compare strains of Kentucky bluegrass both when grown in association with white clover and when grown alone with heavy applications of nitrogen fertilizer, significant differences among strains were revealed only under the latter condition. An excellent stand of clover apparently masked differences among the bluegrass strains when grown with the white clover.

Considerable data were accumulated relative to size inheritance in crosses between Ladino and ordinary white clover. The genetic mechanism suggested is some type of multiple factor interaction with possible dominance of large size. The additional evidence collected on inheritance of leaf pattern in this same species confirmed earlier conclusions, namely, that leaf pattern was controlled by multiple alleles. Genetic studies were continued on young plant characters in orchard grass and flower color in alfalfa.

Studies of the effect of heat treatment on meiotic irregularity in orchard grass are still incomplete but irregularities have appeared particularly at the higher temperatures as evidenced by the large number of univalents present at metaphase I. In the studies of aneuploidy in this species 10 additional plants have been found with 29 chromosomes. Appropriate crosses have been made in the hope of obtaining a series of trisomic plants. Chromosome counts are being made on backcrosses of 35-chromosome to normal 28-chromosome plants. Results thus far show a range from the euploid 28 to aneuploid 35 with 29 most frequent. Data were collected on the possible relation of two primitive forms of orchard grass each with 14 chromosomes to commercial orchard grass which normally has 28 chromosomes. Colchicine has been used to double the chromosomes of the primitive forms and appropriate crosses have been made to ascertain compatibilities.

Pathology

A strain of meadow fescue immune to crown rust remained free of infection in further greenhouse tests. Several of the more promising lines of orchard grass were established in a disease nursery. During three years of observations in a disease nursery, a Kentucky strain of red clover was superior to most commercial strains and equal or superior to most Pennsylvania selections tested for stand survival and recovery following clipping. The seed viability of strawberry clover, like Ladino clover, was reduced by Spergon.

A striking yellow blotching of Ladino clover leaves was transmitted mechanically and by stolon grafts to peas and Ladino clover. Numerous single ascospore isolates of Sclerotinia trifoliorum pathogenic to Ladino clover were compared culturally. Treatments to induce formation of apothecia under artificial conditions are underway. Isolates of the alfalfa wilt bacterium (Corynebacterium insidiosum) were compared culturally and found to differ only in pigmentation. Attempts to induce variation were unsuccessful.

Physiology and Composition

Results from the management studies on the effects of time and height of cutting orchard grass-Ladino clover and brome grass-Ladino clover associations with and without spring application of nitrogen fertilizer were in

accord with the results from the previous two years. During the summer of 1946 a decrease in the amount of clover occurred which could not be accounted for by either the management treatments or weather conditions. Sclerotia of Sclerotinia trifoliorum were present on the plots in the spring, and, in the fall of 1946, apothecia were being produced in abundance. Whether this disease was the cause of the relatively poor growth of the clover during the year was not determined. On the brome-grass-Ladino clover plots clipped to prevent crowding of the Ladino, Kentucky bluegrass was making ingress and the brome-grass was disappearing. The more severe the clipping treatment the lower was the yield of brome-grass and the greater was the amount of Kentucky bluegrass and Ladino clover.

Photoperiodic responses of orchard grass, brome-grass and Canada blue-grass obtained in the greenhouse during the winter months substantiated those obtained in 1944-45. Flowering heads were produced on orchard grass and Canada bluegrass when the normal winter night was interrupted with 1/16 hour of artificial light at midnight. On brome-grass, heads were produced when the interval of light at midnight was 1 hour, 1/2 hour, or 1/4 hour, but no heads were produced under treatments with 1/8 or 1/16 hour. In general, the time from the initiation of the light treatment to flowering increased as the interval of artificial light was decreased. With brome-grass and Canada bluegrass there was a reduction in the number of heads under the shorter light intervals.

Spring applications of ammonium sulphate to pure orchard grass at rates of 30, 60, and 120 pounds of nitrogen per acre gave higher yields, higher percentage nitrogen contents, and higher nitrogen recovery than fall applications. Results with band placement of phosphate for orchard grass and Ladino clover have not been promising. Drilling orchard grass in rows rather than seeding broadcast has not helped in maintaining Ladino clover.

In plots of bluegrass and white clover severe loss of white clover occurred during the winter irrespective of management practices of fertilization. Greater winter injury resulted on plots receiving 150 pounds of K_2O per acre in the fall than on plots receiving no potash. Clipping to a height of 2 inches gave lower yields than closer clipping on both irrigated and nonirrigated plots and irrespective of the level of nitrogen fertilization. The soluble carbohydrate content of rhizomes and stubble from selected plots of Kentucky bluegrass increased greatly between October 24 and November 26.

An experiment designed to show the effect of temperature on the utilization of reserve substances in perennial ryegrass has been completed and the results summarized. High temperatures induced the rapid depletion of soluble carbohydrates from stubble and roots with little production of new top growth. Other constituents did not decrease on a percentage basis.

PART III

PASTURE RESEARCH AT STATE STATIONS

STORRS (CONNECTICUT) AGRICULTURAL EXPERIMENT STATION

Title: Alfalfa Experiments.

Leaders: B. A. Brown and R. I. Munsell.

No new data were obtained in 1946. On another series of 88 plots, 22 different treatments were applied and all seeded in August to the wilt resistant variety of alfalfa "Buffalo". If this variety persists as well on these new plots as in the variety trials of 1941-45, better measurements should be obtained of the effects of the fertilizers.

Title: The Maintenance and Improvement of Pastures.

Leaders: B. A. Brown and R. I. Munsell.

a. The Effects of Fertilizer Treatments on the Soil, the Flora, and the Production as Measured by Grazing. For the twenty-sixth year, the experimental permanent pastures were grazed quantitatively by yearling cattle, Holstein heifers, in 1946. In general, production was slightly above the long-time average, due to quite adequate precipitation, especially in August.

Eight of the seventeen pastures produced the equivalent of over 1500 pounds per acre of total digestible nutrients or as much or more as in 1-1/2 tons of hay or a ton of grain. The three most productive pastures were: (1) NPK, (2) LPK (annually), and (3) LPK (disked and Ladino seeded in 1943). The three poorest plots in order of increasing yields were: (1) no fertilizer, (2) LPK (no P since 1924), and (3) P.

The efficiency of feed production on permanent pastures is illustrated by the fact that, by top-dressing with only LPK at an annual cost of less than 5.00 per acre for fertilizers, total digestible nutrients equivalent to nearly a ton of grain have been obtained in each of many years.

c. The Effect of Various Chemicals on the Soil, on the Botanical Composition of the Sward and on the Stands and Growth of Kentucky Bluegrass and Rhode Island Bentgrass. Discontinued in 1946.

d. The Adaptability of Varieties and Species of Grasses and Clovers for Pastures.

1. The management studies of Ladino-grass mixtures were continued in 1946, the seventh complete season. Regardless of the system of cutting practiced in this experiment, the stands of clover were still good in

October 1946. At that time, most of the plots had at least 50 percent of their areas occupied by Ladino. In spite of a very wet period from July 20 through August 1946, both stands of clover and yields of dry matter were considerably below those of 1945, which was by far the most productive season in the history of this experiment. It is of interest that 1945 followed two very dry seasons in which the stands of clover and the yields were far below average.

The 7-year average acre yields of dry matter from the Ladino-timothy plots (on which there has been little timothy and much bluegrass) vary from 3500 pounds for the 6- to 4-inch system to 5200 pounds where the first cutting is not made until June 15 and followed by 6- to 2-inch cuttings for the rest of the season. On the Ladino-orchard grass area, where no first cutting is made later than June 1, the comparable range in yields is from 3400 pounds for the 8- to 4-inch system, with no harvests after September 1, to 4400 pounds from the 10- to 2-inch plots. Regardless of height when cut, setting the mower to cut two inches above the ground has consistently given appreciably larger yields of dry matter than leaving a 4-inch stubble. The grand-average difference for both seedings during the seven years is 500 pounds per acre.

2. Crops for fall pasture: in 1946, for the third consecutive year, barley and oats were seeded about August 1. Yields were determined for two rates of seeding, three N treatments and two systems of harvesting. The results have not been summarized at this time (January 30, 1947).

f. Causes of Fluctuations in the Prevalence of White Clover. For many years, the results at this station have shown the importance of LKP fertilization in maintaining large amounts of white clover in grass-clover stands. After the initial treatments, K is most likely to be deficient. This is illustrated by the following summary of data from a long unplowed meadow (all plots had LPK in 1942):

<u>Annual Treatment</u>	<u>Percent Clover in 1946</u>
PK (L omitted since 1942)	52
LK (P omitted since 1942)	46
LP (K omitted since 1942)	10

On another field with considerable reserve P and K in the soil when seeded in 1938 to Ladino and orchard grass, omission of P for nine years has been quite unimportant in maintaining stands and yields, but omission of K resulted in a 75 percent reduction in the prevalence of Ladino and a 55 percent decrease in yields of dry matter in 1946. Even on the grazed pasture plots, where in earlier years there was little response to K, there is now much more native white clover with LPK than LP fertilization.

Insects cause considerable damage to white clover and this was very conspicuous in 1946. Many leaflets were almost entirely eaten, while others became reddened, presumably because of leaf hopper. From observations, it appears that these insect injuries are more important in reducing current yields than in thinning stands.

DELAWARE AGRICULTURAL EXPERIMENT STATION

Title: Palatability of Certain Pasture Grasses.

Leader: C. E. Phillips.

In palatability studies of four tall pasture grasses in 1946, the cattle showed a slight preference for Lincoln brome grass over orchard grass. Reed canary grass was definitely third choice and Alta tall fescue a very poor fourth. The cattle, milk cows, had free choice with plenty of pasture available. The grasses were seeded in combination with Ladino clover. The studies will be continued in 1947.

MAINE AGRICULTURAL EXPERIMENT STATION

Title: Grassland Studies.

Leader: C. H. Moran.

Studies of the improvement of pastures through the use of lime and fertilizer were continued at Highmoor Farm. The top-dressed pastures were grazed from 1941 to 1945 by milking cows and young stock. It was decided to obtain a check on these results by grazing with Hereford steers. Animal groups were balanced and assigned to pastures for the season. They were weighed at weekly intervals and the weight changes and maintenance weights were calculated in terms of TDN. The values in turn could be calculated in terms of 4 percent milk according to the formula of Knott, Hodgson, and Ellington for comparison with the previous data. It can be seen from Table 10 that a rather close check was obtained.

Table 10. Gains of Hereford steers in terms of 4 percent milk on differently treated pastures.

Fertilizer				Time		4 percent milk	
pounds per acre				of		pounds per acre	
Nitrogen	P2O5	K2O	Application			1941-45	1946
0	0	0	Spring	:	:	1214	1245
100	0	0	Spring	:	:	2913	1531
0	50	50	Spring	:	:	3962	4322
0	100	100	Spring	:	:	4727	4697
50	50	50	Spring	:	:	4896	5067
100	100	100	Spring	:	:	5660	7193
60	60	60	Spring	:	:	3750	3961 *
60	60	60	Fall	:	:	3650	3885 *

* Rough, stony land.

When the weekly weights were compared it was found that the untreated pastures were producing only enough feed for maintenance during July and August. If the steers had continued at the rate of gain that was made in May and June they would have gained a total of 250 pounds or 2.1 pounds per day. Preliminary studies at three locations in Maine this past year have indicated that a gain of 2 pounds per day can be expected from beef herds on Ladino-grass pastures.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

Title: Trials with Sorghum and Sudan Grass Strains.

Leader: U. G. Colby.

Notwithstanding the superior performance of a well-established, well-managed Ladino clover-bromegrass pasture during the hot months of July and August, the need for additional grazing is frequently apparent particularly during dry, hot seasons. One of the best crops available for providing supplementary grazing at this time is Sudan grass or possibly sweet sorghum. Both crops produce heavy yields of palatable nutritious feed. If a reasonable amount of care is exercised in seedbed preparation, fertilizing and seeding, crop failures are rare. Thus far, however, dairymen have been cautious about growing either of these species largely because of the possible danger of cyanide poisoning.

Last season several strains of Sudan grass and one of sweet sorghum were grown. In addition to obtaining yield data, tests were made of the cyanide content of the herbage at two growth stages. The Rancher strain of sweet sorghum was obtained from South Dakota where it was bred for low cyanide content.

Samples were first taken for cyanide determination on July 22 when most strains were in full head. All plots were then cut, the hay removed, and an application of ammonium nitrate made to supply elemental nitrogen at the rate of 65 pounds to the acre.

Samples for a second test were taken on September 12. All chemical determinations were made by Professor Emmett Bennett of the Department of Chemistry.

Table 11. Comparative HCN content of three strains of Sudan grass and one of sorghum.

Strain	HCN (mg. per 100 grams dry matter)			
	July 22	September 12		
		Leaves	Stems	
Rancher sorghum	14.7	49.7	32.1	
Tift Sudan	13.9	36.2	23.6	
Sweet Sudan	2.5	56.6	33.6	
Commercial Sudan	6.8	43.8	34.0	

On the second crop there was a serious outbreak of Helminthosporium blight, particularly on the commercial strain of Sudan grass. Some blight appeared on the sweet sorghum and also on the sweet Sudan but Tift Sudan seemed to be completely immune.

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

Title: Producing the Full Roughage Requirements on New Hampshire Dairy Farms.

Leaders: Ford S. Prince, P. T. Blood, and G. P. Percival.

In this project, we have been endeavoring to see which of the tall grasses is best suited to seeding with Ladino and at the same time to find out whether any of the newer ones are superior to timothy which is more commonly seeded. The work, so far, has been conducted on outlying farms. Original seedings were made on relatively small plots, usually no more than an acre in extent or smaller. It was found difficult to fence and pasture at the time when individual grasses should be grazed. Later seedings have been made with each grass on a field scale on plots large enough to fence economically. This increases the differences due to soil variations, as might be expected. Six outlying pastures were harvested in 1946. For convenience in reporting, a yield summary covering a 4-year period is given in Table 12 for the six grasses under study, all of which had been seeded individually with Ladino clover in 1942 or 1943.

Table 12. Average yields in tons of oven-dry material per acre of certain grasses grown in six New Hampshire pastures, 1943-46.

Grass	: Pasture : years	: Tons of oven-dry : grass per acre
Smooth brome grass	: 16	: 2.82
Orchard grass	: 22	: 2.66
Tall fescue	: 14	: 2.62
Perennial ryegrass	: 14	: 2.53
Timothy	: 18	: 2.50
Reed canary grass	: 12	: 2.46
	: :	: :

It will be noted the yields of all the grasses are very close, there being but 0.36 ton difference between smooth brome grass, the highest, and reed canary grass, the lowest in the group. The fact that Ladino was seeded with each one no doubt tends to iron out yield variations. Reed canary grass and tall fescue appear to offer the most competition to Ladino. Tall fescue makes the most growth in late fall, while the growth of orchard grass is disappointing at this period. Perennial ryegrass is less persistent than the other grasses, its place being more

quickly taken by bluegrass and bentgrasses than is the case with the others. With respect to palatability, at this time our suggested rank in descending order is: smooth brome grass, timothy, perennial ryegrass, orchard grass, tall fescue and reed canary grass. As a result of these trials, farmers on whose farms the tests are located are making an increasing number of brome grass seedings. Comparative tests on these same farms with complex mixtures containing Ladino, Kentucky bluegrass and/or redtop have not yielded as well as the simple mixtures noted.

Title: Seed Production Possibilities of Forage Crops.

Leaders: F. S. Prince, P. T. Blood, and L. J. Higgins.

Severe winterkilling due to ice cover in the early months of 1946 destroyed perennial red clover seedings to the extent that no seed was harvested during the season. In spite of adverse weather in August, one acre plot of the late hay timothy strain was harvested with a combine. About half the seed from each head had shattered due to beating rains. A yield of 75 pounds of seed per acre was secured. August rainfall totaled almost nine inches. A quantity of two strains of smooth brome grass was harvested by hand August 6. This was later threshed with a head thresher and cleaned with a fanning mill. No attempt was made to determine acre yields, although the two strains varied widely in sending up seed stalks and hence in amount of seed produced. Another small lot of smooth brome grass was harvested September 12. This lot proved to have a very much lower percentage of germination, actually 25 percent as compared with a 90 percent germination for that harvested August 6. Whether late harvested brome grass seed would always behave in this manner or whether it was due to heavy August rainfall, we do not know.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION

Title: Fertility Levels on Dairy Farms.

Leaders: C. B. Bender, Firman E. Bear and Claude Eby.

This project has been completed and is now being prepared for publication.

Title: Pasture Fertilization in Relation to Carrying Capacity
(Tyker Farm).

Leaders: C. B. Bender and Claude Eby.

The pasture area of 49.5 acres produced 1504 pounds of total digestible nutrients per acre, representing a carrying capacity of 0.97 of a 1000-pound cow per acre for a grazing season of 135 days. The 56 dairy heifers gained an average of 129 pounds for the season at a cost of 8 cents per pound gain.

Title: Alfalfa Variety Test.

Leaders: C. S. Garrison, C. B. Bender and Claude Eby.

Eight plots seeded at the rate of 20 pounds of the following alfalfa varieties were established August 15, 1946: Kansas Common, Oklahoma, Buffalo, Atlantic, Ranger, Northern Common, Ontario Variegated and Ladak.

Observations will be made as to winter hardiness, wilt resistance, leaf-hopper infestation, resistance to heaving and dry-matter yields.

Title: All Roughage and Pasture Program.

Leaders: M. A. Sprague and C. B. Bender.

A study to determine the maximum use which can be made of the more economic feeds, hay, silage, and pasture, has been planned and established during the past two seasons (1945 Annual Report, page 91). As productive pastures as possible have been established and these will be supplemented with silage, hay and in some cases grain rations.

Five 4-acre pastures are included in the study and are uniformly maintained in a high state of fertility by liberal annual applications of lime and fertilizers. One of these was kept in a Kentucky bluegrass-white clover sod. The other four have been sown to Ladino clover, one with brome grass and one with tall oat grass in August 1945, and one with orchard grass and the remaining one with reed canary grass in August 1946. An excellent stand of Ladino has been obtained on all areas and of grass in all but the pasture seeded to reed canary grass. Overseeding on frozen ground on this plot is anticipated this spring.

Three lots of dairy cattle have been put on feed as follows: (1) exclusively U. S. No. 1 alfalfa hay and silage, (2) hay and silage plus one pound of grain per three pounds of milk, and (3) hay and silage plus one pound of grain per six pounds of milk produced. All three lots will be afforded abundant grazing, rotating from pastures 1 to 5 beginning in April 1947.

Preliminary grazing in 1946 of the pastures seeded in August 1945 showed a total of 195 cow-grazing days per acre from the brome grass-Ladino clover, 98 cow-grazing days from the Kentucky bluegrass, and 101 cow-grazing days plus 1-1/2 tons of hay per acre from the tall oat grass-Ladino clover pasture. Digestion studies in connection with these trials are planned as a further study of possible varietal advantages.

Title: Korean Lespedeza with Continuous Small Grain.

Leader: Herbert R. Cox.

Since 1943, work has been conducted with certain farmers who have grown oats with Korean lespedeza. Following the original seeding oats is

again planted every spring after the field is disked. Thus the land produces every year a crop of oats plus a volunteer stand of Korean lespedeza for summer and fall pasture.

Of the eight tests started between 1943 and 1945 only three were continued through 1946. One of them has been reasonably successful since its establishment in 1944, producing every year a fair crop of oats and a thick stand of volunteer lespedeza. It is noteworthy that the soil in this field is strongly acid and has a fairly low fertility level. In the other tests carried on through 1946 the Korean lespedeza made only a poor to fair stand by selfseeding and was severely crowded by volunteer weeds, grass and clover.

From evidence accumulated in the past four years there is strong indication that this system of continuous small grain and volunteer lespedeza has little place on most New Jersey farms. There appear to be several reasons for the plan not being more satisfactory. In most cases there were fairly vigorous stands of grass, clover and weeds competing with the lespedeza. Apparently disking alone in most cases is not a good method of seedbed preparation for oats. Furthermore, with the use of lime and fertilizer, grass and clover quickly gain the ascendancy, even where a fairly thorough job of disking has been done. Since the liberal use of lime and fertilizer is highly profitable in growing the feed crops there does seem to be little need on most New Jersey farms, which normally receive large applications of fertilizer, for a crop such as the annual lespedezas which are most outstanding in being able to tolerate marginal soil conditions.

Title: Pasture Renovation Studies.

Leaders: J. L. Haynes and M. A. Sprague.

No new renovation trials were initiated during 1946; the several already in existence were followed rather closely for timely observations of responses to reseeding and fertilizer applications on several soil types (1945 Annual Report, page 86).

On a Nassau shale loam soil in Sussex County heavy applications (500 and 1000 pounds per acre) of a 5-10-5 fertilizer were used in 1945 in an attempt to obtain a successful renovation. Fair to good initial stands of orchard grass, timothy and brome grass were obtained where 1000 pounds per acre were applied. All other seedings were complete failures. The fertilizer and some lime applications were made in the fall of 1945. By midseason 1946 the few surviving plants were weak and spindly in appearance with symptoms generally associated with low nutrient level.

Special attempts were made to insure seed coverage of the larger seeded grass species in surface seedings on heavy residual sod. Orchard grass, brome grass, tall oat grass and reed canary grass

survived only in the furrows cut by the disk. These furrows (perpendicular to the slope) filled with silt covering the seed. This situation was not experienced with the small seeded clovers and timothy.

Measurements were made of plant expansion from row seedings of various grasses on bluegrass sod in 1940. The tests were on Nassau shale loam. The measurements of spread expressed in average radius of spread are (a) tall oat grass 1.1 feet; (b) reed canary grass 0.8 foot; (c) creeping brome grass 0.7 foot; (d) orchard grass 0.3 foot; (e) meadow foxtail, no change; (f) tall fescue, 95 percent decrease in stand; (g) noncreeping brome grass, complete loss of stand. This would indicate the necessity of severe treatment of the existing sods in renovation practices in order to reduce competition for the newly seeded grass species.

Studies are underway dealing with the relationship of lengthy liming programs to success of reseeding on worn out pastures. There are indications that lack of lime penetration not only reduces the efficiency of fertilizer treatments but also increases drought susceptibility through sharp curtailment in depth of root development. Absorbing roots do not survive well in a calcium-free medium and the minimum level of calcium necessary for normal root growth is raised by increasing the general nutritional level of the plants through fertilizer applications. These considerations may partially account for the poor initial performance of species introduced through reseeding practices on low fertility pastures where lime and fertilizer treatments are made at the time of seeding.

Title: Beef Cattle Experiment with Orchard Grass.

Leaders: M. A. Sprague and George Van der Noot.

During the 1946 grazing season this experiment as originally set up was completed and plans are already underway for revamping the experimental area for the study of additional phases of beef cattle pastures in New Jersey.

Thirty head of yearling grade Hereford steers, approximately 500 pounds each, were purchased in April 1946 and were used to graze these five 4.6-acre pastures (1943 Annual Report, page 87, for account of seedings and fertilizer gradients of the pastures) from April 28 to October 8. The animals were rotated from one pasture to the other in order to make best use of the available forage. No other feed was provided.

Ten head of steers were sold on July 18 after 84 days of grazing, making an average gain per animal of 0.46 pound per day. The remaining 20 steers continued grazing until October 8 and during the 158 days on pasture gained an average of 0.96 pound per animal. The total yield per acre of beef during the season was 148 pounds. In addition there was an average of 0.9 ton of hay harvested per acre which must be added to the beef yields for an indication of total production. This is considered an excellent yield from these 23 acres of land, reclaimed in 1935 from a poorly drained cut-over woodlot.

Pastures 1, 2, 3 and 4 were outstanding in production during the 1946 grazing season, being nearly twice as productive as Pasture 5. Pasture 1, consisting of orchard grass (Ladino clover was seeded in two previous years but no Ladino was present in 1946) and fertilized with 400 pounds of 0-20-20 fertilizer each year, gave 215 steer grazing days per acre. Pasture 2, consisting of pure orchard grass fertilized with 1000 pounds of a 5-10-5 fertilizer per acre annually, gave 232 grazing days per acre. Pasture 3, of orchard grass (up until the 1945 season there was a fair stand of alfalfa and birdsfoot trefoil) fertilized with 400 pounds of an 0-20-20 annually, gave 117 grazing days plus 1.6 tons of air dry hay per acre. Pasture 4, of orchard grass (red clover was originally included) with 400 pounds of an 0-20-20 per acre applied annually, gave 132 grazing days plus three tons of hay per acre. Pasture 5 had never been seeded to a legume and pure orchard grass fertilized with 400 pounds of 5-10-5 per acre annually, gave only 132 grazing days per acre. This was about half of what the other pastures produced which had an adequate source of nitrogen provided, whether by a complete fertilizer or an included legume.

Title: Grasses and Legumes for Poultry Ranges.

Leaders: M. A. Sprague and C. S. Platt.

A continuation of the study of bluegrass, Ladino clover and ryegrass ranges in poultry raising was carried out this past season. There was no change in the design of the trials and results were generally in accord with those obtained during 1945 (1945 Annual Report, page 90).

Most outstanding among the several ranges was Ladino clover which exhibited an amazing capacity for rapid recovery after grazing, and this was especially outstanding when compared with the other ranges, during the midsummer season. The ryegrass (Lolium perenne) was relished by the birds and although it became dry and dormant during the middle of the growing season the birds maintained on it consistently consumed slightly less feed than those on the other ranges.

Again, no appreciable saving was observed in total feed consumed by birds on range when compared with those in confinement. However, a pronounced saving in cost of feed was significant, as a lower cost feed could be supplied the birds in place of the expensive concentrates, containing the necessary minor elements of nutrition, required by the birds in confinement. Additional benefit was experienced in range-fed birds in the form of a better bird and increased egg production during the first three months of laying.

CORNELL UNIVERSITY (NEW YORK) AGRICULTURAL
EXPERIMENT STATION

Title: Breeding and Cytogenetic Investigations with the Forage Plants of New York.

Leaders: S. S. Atwood, R. P. Murphy, R. G. Viggans, and L. F. Randolph.

In the red clover plots sown in 1944, a fair survival of individuals was observed at the time the plots were cut for hay in June 1946. During the early part of September, when certain plants were conspicuous because of their aftermath growth, individual plant selections were made. Cuttings taken from the crowns of the selected plants were rooted in pots, and at the onset of freezing weather they were moved into the greenhouse. Many of the cuttings have died from what appears to be a complex of diseases, but some of the survivors are growing vigorously and will be transplanted to the field next summer. It is of interest that none of the crowns dug in the field was free from root borers.

On the basis of the selfed seed available and the notes taken in 1944 and 1945, inbred lines were established in 1946 from 206 clones of bromegrass, selected from the 1944 space-planted nursery. From 1 to 4 replicated 10-plant rows were started for each parental clone, making a nursery of about 6000 total individuals, including check rows. Notes were taken on the first year's growth and establishment of these plants. Also 192 self-sterile clones were selected from the same original nursery, and 12 cuttings of each of the plants were planted in a replicated polycross block in June 1946. Here also notes have been taken on the first year's growth. Similar inbreeding nurseries with timothy and tall oat grass and a polycross nursery with timothy were established from selected plants, but with both of these species the number of plants being studied is less than with the bromegrass.

Since the 1944 space-planted brome nursery included a wide range of valuable seed collections, additional detailed notes were taken in 1946 on such characters as disease resistance, vigor of hay growth, lodging, maturity, and vigor of aftermath. The 200 plants which were selected are being maintained in cold frames until they can be transplanted to polycross nurseries next spring. Some of the plants selected as outstanding in 1944 and 1945 were severely injured with Helminthosporium root rot in 1946, while other plants were outstanding in all three years.

New space-planted nurseries were established in 1946 at Tully, New York, as follows:

	<u>Individuals</u>
Timothy	8510
Reed canary grass	4250
Meadow fescue	6270
Tall oat grass	2450

The seed lots used for this planting were all collections that are being tested in plots as part of the other forage breeding project. The different lots were planted separately in replicated plots of 100 plants each in order to obtain additional information on the type of variation between lots.

A repeat planting of the Red Clover Uniform Disease Nursery was made in 1946, but with Doctor Tyler of the Department of Plant Pathology on leave from the University, few notes were taken on this material. The parts of the plots inoculated with Sclerotinia killed 100 percent during the winter.

Detailed notes were taken on several characters throughout 1946 for all of the polycross nurseries established from the clones selected in the Agronomy Department plots. The clones were rogued, usually before flowering occurred, and seed was harvested from the following numbers of selected clones:

Brage orchard grass	26
S.143 orchard grass	28
S.48 timothy	25
Victoria ryegrass	10
E.F.79 ryegrass	21
Jaedersk ryegrass	10
N.Y. red fescue	47
English meadow foxtail	50

When the seed from these clones is threshed, plans will be made for progeny testing in 1947.

An additional seed harvest was obtained in 1946 from the isolation plots of 1777 and 4059 timothy. Widespread increase of this material will not be attempted until decisive results are available from the recently established test plots.

A cytological study of birdsfoot trefoil showed that the surviving plants from an old field, having a mixture of wide- and narrow-leaved types, had either 12 or 24 chromosomes. Since no intermediate or aneuploid numbers were found, it appears that crossing of the two species takes place very rarely, or if it does take place the triploid or aneuploid progenies do not survive in competition with the parental types.

The zigzag clover plots were continued in 1946, but yields were not taken because of contamination with weeds.

Work with the 4n red clover was discontinued in 1946.

Title: Strain Testing and Breeding of Forage Plants for New York State and Vicinity, with Special Emphasis on Problems of Production during Periods of Midsummer Drought.

Leaders: R. P. Murphy, H. A. MacDonald, S. S. Atwood, and H. R. Fortmann.

The varietal plots established in 1945 as part of this project were harvested for yield in 1946, but the reliability of the results varied widely for the different species. For example at Ithaca the brome grass winterkilled severely, and only certain plots were cut for yield. The associated alfalfa also winterkilled but in a very uneven pattern over the plots. The brome grass plots at Churchville, on the other hand, had good stands, but their second cutting yield was low due to dry weather and to leaf-hopper damage in the associated alfalfa. Most of the orchard grass, tall oat grass, timothy, reed canary, and meadow fescue plots were cut for yield, some three times and others twice. The associated Ladino clover made good growth in all of the mixture plots. The data from these plots are now being summarized and analyzed.

Most of the grass varieties sown in 1945 were sown again in plots in 1946, both at Ithaca and at Churchville. By spraying the Ithaca field on July 2 with one gallon per acre of 20 percent 2,4-D solution in 200 gallons of water, most of the annual weeds except the foxtail grasses and most of the perennial weeds except quack grass were effectively controlled.

A further study of aftermath growth at controlled high temperature is being made in cooperation with the U. S. Plant, Soil, and Nutrition Laboratory. In addition to repeating five clones of brome grass, the study includes ten clones each of Brage orchard grass and S.143 orchard grass, and five each of S.48 timothy, tall oat grass, and English meadow foxtail. Following the hay crop, the temperature will be raised and yields of the aftermath will be measured.

Another series of plots, to be included in this project, were established in 1946 in order to study, in cooperation with the Agronomy Department, the performance of five brome grass varieties under three clipping treatments and several types of nitrogen application. A good stand has been obtained, and a marked response to the first N application was observed. Soil samples, taken from each plot before treatment, have been analyzed for comparisons with subsequent samples.

Title: The Value of Birdsfoot Trefoil as a Pasture Legume in New York.

Leader: H. A. MacDonald.

The investigations relative to the pasture value of birdsfoot trefoil were continued in 1946. Since the older seedings were discontinued and new seedings established new data from these will not be available until 1947. The new seedings include plantings from all available seed sources.

During the past year birdsfoot trefoil produced high pasture yields during the summer and fall months. It was lower yielding than Ladino white clover under pasturage during the spring months. It increased the total seasonal yield of all mixtures to which it was added.

Seed production of this legume continues to be one of the most pressing problems. During the past summer significant seed yield increases were obtained from two cultural treatments out of ten under investigation. They were (1) early spring clipping to check the vegetative growth and (2) topping or heading the crop in the late bud stage. Further studies relative to this problem are now underway.

Seed increase of two promising selections is now in progress. Further selection and study are being continued.

Title: The Effect of Stage of Growth When Cut upon the
(1) Nutritional Values, (2) Yield of Hay and Aftermath,
and (3) Longevity of Stand of the Principal Perennial
Forage Grasses and Legumes.

Leader: H. A. MacDonald.

Object. To obtain the basic information on the response of forage crops to different types of management, needed to develop systems of grassland management for (1) spreading the harvesting period, (2) providing for well distributed aftermath grazing, and (3) production of high quality forage.

Procedure. The grasses and legumes which appear to have potentialities in this area for hay, grass silage and pasture are being grown alone and in various combinations. The investigation was started in 1944 with the seeding of five grasses, six legumes, and twelve combinations. Excellent establishment was obtained in all cases. Yields at five distinct stages of growth were obtained in 1945 and 1946. Systematic records are being kept relative to growth rates, botanical composition, leaf stem ratios, chemical composition, etc. The trial will continue during 1947. New seedings were made in 1946 as a replicate of the investigation in different years.

Progress. Preliminary results only have as yet been obtained from this investigation. Significant differences have been obtained in early growth, hay yield, aftermath production and maturity. Differences were found in loss from these crops following maturity and in the composition of the various plants at different stages of maturity and between plants at the same stage. The data are not yet sufficiently complete to report in detail or to draw specific conclusions.

Title: The Influence of Fertilizer Treatment on the Chemical and Botanical Composition of Pasture Herbage and upon Yield and Seasonal Distribution of Growth.

Leader: D. B. Johnstone Wallace.

This investigation is being continued as previously described. Fertilizer treatment has in all cases improved the yield and composition of the herbage produced where a balanced treatment was applied. On the plants under study, phosphorous and lime have been of greatest value with potash giving beneficial results when accompanied by calcium.

Nitrogen fertilization was beneficial in the preliminary trials where legumes were not present. Its frequent use reduced the legume population and resulted in an increase in the amount of undesirable grass and weeds. The continued use of sulphate of ammonia alone resulted in an unproductive plot of increased soil acidity. The supplementary use of nitrogen on seeded established plots increased both the yield and protein content of the herbage. Very late fall and early spring applications were most detrimental to the white clover in the sward. This appeared to be due to its influence on grass growth in early spring.

Title: The Influence of Methods of Grazing Management upon the Yield, Chemical Composition, and Botanical Composition of Pasture Herbage.

Leaders: D. B. Johnstone Wallace and W. K. Kennedy.

The data obtained from this investigation indicate that clipping or grazing wild white clover-Kentucky bluegrass pasture herbage to 1/2 inch gives a more desirable sward and greater yield than when clipped to 1, 2, or 4 inches. The total yield of dry matter was found to be greatest when clippings were made at intervals of from 6 to 8 weeks. The percentage of white clover and the percentage of protein in the herbage was much reduced by this practice, however. Clipping at intervals of every two weeks or less encouraged the encroachment of bentgrass and low growing weeds with a corresponding reduction in yield although the clover content was maintained.

Clipping when the vegetation was from 4 to 6 inches in height to a height of about 1/2 inch allowed the white clover to be adequately maintained and produced a high yield of high protein herbage.

Title: A Study of Plant Associations for Pasture Purposes.

Leader: D. B. Johnstone Wallace.

The older series of investigations as previously presented have been replaced by new trials. These trials are now in their first harvest year and therefore the results are not conclusive. Many of the 1946 data have not as yet been summarized.

The techniques previously described are being used to evaluate herbage production and quality. Ladino white clover in combination with leafy strains of orchard grass continues to give high yields under a rotation system of management. Mixtures of wild white clover and Kentucky bluegrass have given consistent high spring yields but suffer severely in midsummer and early fall. This combination has been greatly improved by the addition of birdsfoot trefoil. Red fescue in association with wild white clover has given herbage yields equivalent to the bluegrass-white clover combination. Tall fescue over a period of years has given superior forage yields but has not been palatable to stock where free choice is allowed.

A new series of grass-legume mixtures for silage is now under study. Excellent first year yields have been obtained. The value of the various mixtures under study will best be determined when the influence of the management treatments applied becomes evident. Based on previous trials, it appears that mixtures for silage can be divided into three groups largely dependent upon the legume used and its management requirements. (1) Wild white clover-grass mixtures cannot be expected to produce a maximum of grass silage. Mixtures of this type may produce one medium silage cut and should be pastured the rest of the season. (2) Alfalfa-grass mixtures will not withstand frequent cuttings for silage. The alfalfa in this area may best be managed to produce one cutting for grass silage and be preceded or followed by a cutting for hay at bloom stage in order to protect the alfalfa stand. (3) Ladino white clover-grass or birdsfoot trefoil-grass mixtures may be used for two or more silage cuttings. They may be used for pasture or hay or combinations of hay, silage and pasture management. Of the grasses, brome grass and orchard grass appear to offer the most promise for grass silage use.

In the pasture technique study manurial treatments equivalent to the amount of manure deposited on pasture under grazing or the return of a comparable amount of pasture clippings have greatly increased the herbage yield and winter hardiness of the species under study. This may be attributed to the additional nitrogen made available or to some associated factor.

Title: Alfalfa Snout Beetle Investigations.

Leaders: H. H. Schwardt and L. D. Newsom.

Tests with the newer formulations of DDT and with hexachlorocyclohexane indicate that these materials are highly effective against the alfalfa snout beetle if properly applied. Baits containing these materials gave erratic results in field tests and in general compared unfavorably with the standard baits in which sodium fluosilicate was the poisonous ingredient. The apparent inferiority of these baits probably was increased by their slow action on the beetles.

Much better results were obtained with DDT and hexachlorocyclohexane in a series of cage tests in which the plants were sprayed and then massively infested with several successive lots of beetles. A summary of data from these cage tests shows that DDT killed 96 percent of the beetles introduced, hexachlorocyclohexane 95 percent, peanut hull-sodium fluosilicate bait 63 percent, and only 9 percent of the beetles died in check cages. Of further interest is the fact that plants in the sprayed cages were not fed upon while those in the baited and check cages were almost entirely consumed. Beetles removed from the sprayed cages after three days became progressively weaker and usually died after an interval of 7 to 9 days. During this period they did not feed on the fresh alfalfa offered, and produced no eggs.

Title: Clover Insect Control.

Leaders: H. H. Schwardt and L. D. Newsom.

Hay yields from red clover were increased approximately 10 percent when the crop was dusted four times with either 1 percent DDT or 1 percent hexachlorocyclohexane. Fifty pounds per acre were applied. Two applications of either material at either 2 or 3 percent strength were in general less effective than the 1 percent applied four times. The increased yields were believed to be due to control of the clover head weevil, Hypera meleus, and the meadow spittle insect, Philaenus leucophthalmus. Species present in smaller numbers but also significantly controlled were the clover seed weevil, Tychius griseus, the tarnished plant bug, Lygus oblineatus, the clover root curculio Sitona hispidula, the potato leaf hopper, Empoasca fabae, and various aphids. Effective control of the clover root borer, Hylastinus obscurus, was not obtained.

The average DDT residue on cured hay from all DDT treated plots was 10.7 parts per million. This hay was fed to a lactating cow over a 2-month period and her milk analyzed. The DDT content of the milk rose to a maximum of .92 parts per million 48 days after feeding began. No symptoms of DDT poisoning were observed in the test animal.

Title: European Chafer (Amphimallon majalis) Investigations.

Leaders: H. H. Schwardt and L. D. Newsom.

During the summer of 1945 it was demonstrated that sprays containing 5 pounds or more of DDT per 100 gallons were effective against adults of the European Chafer. In 1946 the U. S. Bureau of Entomology and Plant Quarantine and the New York State Agricultural Experiment Station and the Department of Entomology of Cornell University cooperated in spraying approximately 1000 acres of woodland and scattered trees in the infested area around Newark, New York. While a good kill was obtained for the first few nights after treatment, the duration of the

residual effect was only slightly over two weeks. Due to the short period of residual action, the brief interval during which sprays can be considered effective (the ten days between first emergence of beetles and first oviposition) and the inaccessibility of much of the infested woodlands, spraying gives little promise as a means of eradicating the insect. Its effectiveness in reducing local infestations cannot be accurately appraised until observations on the 1947 beetle flight have been made.

PENNSYLVANIA AGRICULTURAL EXPERIMENT STATION

Title: The Adaptation of Species of Grasses and Legumes to the Varying Soil and Climatic Conditions in Pennsylvania.

Leaders: J. K. Thornton and H. V. Higbee.

In April 1944 experiments were started in Clearfield and in Crawford Counties. This was part of a projected program whose object was to determine the adaptability of grasses and legumes, singly and in combinations, to varying soil and climatic conditions, as measured by establishment, persistence and productivity.

In Crawford County, the plots were located in a field which had been abandoned for farming for over 40 years. Typical vegetation was poverty grass, redtop, cinquefoil, and devil's paint brush. The soil ranged from Volusia to Canfield in type and was representative of extensive areas of that county and the northwestern glaciated region. The soil drainage was such as to be relatively unfavorable to alfalfa, but relatively favorable to alsike clover and timothy.

Before seeding the plots, lime at the rate of two tons per acre and 3-12-6 fertilizer at the rate of 600 pounds per acre were applied. In the spring of 1946 an additional 600 pounds of an 0-14-7 was top-dressed over the plots.

Ladino clover, alfalfa, and birdsfoot trefoil were the legumes used in these seeding mixtures; most of the mixtures consisted of one grass and one legume.

All air-dry hay weight yields were obtained for both 1945 and 1946 seasons. During the seeding year and in 1945, the grass was not cut early enough and the legumes suffered damage. This was especially true with the orchard grass which smothered the Ladino severely.

From results to date, it is indicated for Crawford County:

1. Timothy and birdsfoot trefoil are the most productive mixture for hay. From two cuttings in 1946 it yielded 7685 pounds of air-dry weight per acre.

2. Timothy and birdsfoot trefoil combined well together, both starting growth late in the spring, both bloom about the same time, and the time of cutting the one also favors the other plant.
3. Timothy with legumes yields better than other grasses in combination with the same legumes when grown on this soil.
4. Ladino clover thrives on this soil in combination with any grass provided the grass is cut a little before blooming.
5. It is more difficult to maintain a legume with orchard grass than with any other grass.
6. Bromegrass, an early plant, on a cold soil such as this when not supplied with extra nitrogen shows nitrogen starvation and is easily crowded out by other grasses and weeds. On the same soil the late starting timothy does not show nitrogen starvation.

Title: The Importance of Soil Amendments in the Establishment, Maintenance, and Productivity of Grasses and Legumes.

Leaders: H. W. Higbee and J. K. Thornton.

In the spring of 1944 an experiment was started on Canfield soil at Frenchton in Crawford County to determine what lime and fertilizer rates and ratios were of the most value in establishment, maintenance and productivity of Ladino clover and other legumes and grasses. The site selected for study was representative of a large area of similar nature, which had been depleted of fertility many years ago and which subsequently was permitted to grow up in poverty grass. Residents of that area advised against trying to produce anything on the site.

A soil analysis indicated a need for about 4-1/2 tons of ground limestone per acre to satisfy the lime requirement. The lime applications varied from nothing to four tons per acre. Superphosphate ranged from nothing up to 1500 pounds per acre, and muriate of potash from nothing up to 500 pounds per acre. These applications were made in 22 different combinations and were to be the only applications during the five years of the experiment.

The results after two seasons seem to indicate that the lime requirement listed may be needed for alfalfa, a tap-rooted plant, but that for Ladino clover, a creeping, shallow-rooted plant, not nearly as much lime is required for good production. In fact, it would be difficult to justify the application of more than 2000 pounds of lime per acre, where adequate phosphorus and potash were applied, when judged by appearance of the plots and the yields obtained during either the first or second harvest season. If a ton or less of lime will produce good grass and Ladino clover in the Northwest glaciated

area, as indicated, this is of very great importance in that region, which is essentially best adapted for use as hay and pasture. Most farmers hesitate to apply the amounts of lime at one time that are reported to be necessary on the basis of lime requirement.

The second limiting factor is fertility, because phosphorus appears to be just as important as lime. On the basis of results here reported, most farmers have been applying far too little superphosphate. With adequate lime and potash for Ladino clover, but no phosphorus, the yields are about the same as on the adequately fertilized no-lime plots. A comparison of yields indicates sharp increases from superphosphate up to 750 pounds per acre with the same amounts of lime and potash in each case.

In no case was it possible to show any benefit from the use of potash during the first two seasons.

From the results so far obtained at Frenchton, we believe that similar marginal abandoned land in this area, which has not been farmed for many years, may be transformed into high-grade pastures or hay land within 12 months. We feel certain that Ladino clover will thrive on less lime than alfalfa, but may require more liberal applications of superphosphate than have been recommended in the past.

Title: The Nitrogen Fertilization of Bromegrass.

Leaders: C. B. Knodt and K. M. Autrey.

A field of bromegrass near the College was divided into nine plots and these were then grouped into three comparable replications. The following treatments were used: (a) control; (b) 40 pounds of nitrogen per acre; and (c) 80 pounds of nitrogen per acre. No additional fertilizer was applied. The mean yields (pounds of dry matter per acre) were as follows: control (no nitrogen), 2228; 40 pounds of nitrogen per acre, 3865; and 80 pounds of nitrogen per acre, 3777. The differences in production between the nitrogen fertilizations were not significant. Since this field is in very poor condition, it is planned to supply 400 pounds of 0-14-14 per acre this spring in addition to the various nitrogen treatments. The field will also receive nitrogen fertilization after the first crop of silage is removed.

Title: Silage Investigations.

Leaders: K. M. Autrey, C. B. Knodt, and P. S. Williams.

Experimental work is being conducted upon the possibilities of utilizing 2-quart glass jars as miniature silos for the study of silage preservation. The grasses and legumes utilized were (a) alfalfa, (b) bromegrass-Ladino clover, and (c) orchard grass-Ladino clover. Silages were prepared of each as follows:

1. Unwilted, no preservative.
2. Unwilted, plus 60 pounds of molasses per ton of green material.
3. Unwilted, plus 100 pounds of hominy feed per ton of green material.
4. Unwilted, plus 300 pounds of wheat straw per ton of green material.
5. Wilted, no preservative.
6. Wilted, plus 60 pounds of molasses per ton of green material.
7. Wilted, plus 100 pounds of hominy per ton of green material.

The following results have been obtained:

1. On the basis of the results obtained in these experiments, it appears that the use of 2-quart glass jars as miniature silos offers a convenient technique for studies in silage preservation.
2. Desirable fermentation was obtained in all cases except the unwilted, untreated alfalfa silage. It should be noted that in the B and C silages there was very little clover and the crops were in full bloom.
3. The development of acidity was more rapid in the unwilted than in the wilted silages, and even after 170 days some of the wilted silages were still increasing in acidity. This characteristic was especially noticeable in the alfalfa group.
4. Using pH values as a measure of desirable fermentation, 60 pounds of molasses and 100 pounds of hominy feed, respectively, were equally effective as preservatives under the conditions of these experiments. Silages with straw added and those wilted plus no preservative were well preserved and of good quality, but were somewhat inferior to those in which preservatives were used.
5. There was no destruction of carotene in any of the silages up to 30 days following ensiling, an actual increase being noted in most cases.

6. The mean-sugar content of the wilted silages was 40 and 33 percent higher than the unwilted in groups B and C, respectively.
7. The crude protein content of samples analyzed 60 days after ensiling was 4.90 percent less than that of silage one day old. There was also a slight loss of crude protein attributable to wilting.
8. Analysis of variance of dry matter, nitrogen and pH values of the various silages studied here revealed a coefficient of variation of less than five percent in all cases and less than two percent in some instances. This extremely low variability indicates that very accurate sampling can be accomplished by using glass jars as miniature silos. Another important advantage of the miniature silo technique is that samples may be taken at any interval desired following the ensiling date.
9. Evidently the fermentation changes which occur in 2-quart glass jar silos are similar to those which occur in commercial silos.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION

Title: The Response of Strains and Mixtures of Forage Plants to Grazing.

Leader: Irene H. Stuckey.

Twelve half-acre plots were seeded in the early spring of 1945 on a stone-free silt loam soil which is well drained during the summer, but has standing water or ice sheets over parts of it during the winter. Different strains and species of grasses and legumes were used in the seeding mixtures. Early in July 1945, the entire area was mowed and raked to remove the heavy growth of weeds, but no yields were measured. In August, samples were cut from each plot and dry weights and botanical separations recorded before the entire area was cut for hay.

In the spring of 1946 the individual plots were fenced separately and grazed with heifers throughout the summer. Before grazing, four samples were cut from each plot for dry-weight determinations and botanical composition and, if any large amounts of stubble remained after grazing, additional samples were taken for use in correcting the yields. Records were also kept of the number of days' grazing on each plot. Each plot was grazed when the vegetation appeared to be at a suitable stage of growth, although in some instances at the beginning of the season, it was difficult to decide just what was the best stage. The number of heifers was varied according to the amount of grazing available.

An interesting difference among the mixtures was the distribution of the yields over the season. The plots containing Ladino clover gave 50 percent of the dry matter after the midpoint of the grazing season which for 1946 was July 29, but since this factor is also influenced by grazing management and by rainfall the data are only suggestive at this time. In addition, winterkilling of the Ladino clover was more severe on some plots than on others. The highest yield for the season was 10,731 pounds of dry matter per acre for a mixture containing alfalfa and red clover; the lowest, 5,292 pounds from the paddock growing a northern strain of smooth brome grass and Ladino clover.

VERMONT AGRICULTURAL EXPERIMENT STATION

Title: Cytogenetics and Breeding Investigations with Forage Legumes.

Leader: A. Gershoy.

Trifolium medium. Observations, continued in 1946, of seedlings in progeny rows, based on diallel crosses of better clones, indicate extreme heterozygous state of parent plants. This assumption is based on marked differences in growth and potential yield between reciprocal progeny rows in a cross between any two parents. Such extreme differences demand sampling of large progeny populations. They also point to the improbability of quickly obtaining definitive strains for seed increase.

Over 150 clones of U. S. Department of Agriculture and Vermont Station origin have been set out in 1946 in 15-foot rows. Twenty or more of these selections will be planted in 1947 in an isolated polycross nursery for combining ability.

Yields taken in replicated plots which were seeded in 1945 in timothy and brome association reveal present inferiority of the slow-growing zigzag clover as compared with broad-leaved birdsfoot trefoil or red clover. These plantings have been repeated in 1946 and were seeded at an earlier date. Additional plots were seeded in 1946 to mixtures of alfalfa, red clover, birdsfoot trefoil and zigzag clover with the objective of testing survival value of T. medium and Lotus under extreme competition. There is indicated a need for field studies of techniques for properly seeding T. medium in grass and other legume associations to promote faster growth and to prevent drought injury and winter-killing. This work will be undertaken in 1947 in cooperation with the Agronomy Department.

Lotus corniculatus L. var. vulgaris. From fairly extensive seed-progeny rows set out in 1946, based on selections made in coarse-leaved, tall, imported strains of birdsfoot, winter-hardy, lush types will be placed in 1947 in an isolated polycross nursery.

Trifolium repens var. latum (Ladino clover). Additional polyploids in commercial stocks have been produced by use of colchicine. Mixoploid stolons (diploid, $2n-32$, and tetraploid, $4n-64$) occur necessitating recurrent cytological screening of experimental material. Diploid and tetraploid branches have been set out in the field in clay soil to investigate winter hardiness. Seeds of tetraploids of both controlled and open-pollinated origin have been obtained for progeny row testing in 1947; a small number of F_2 seedlings obtained from hand pollination were grown in 1946 and appear to have promising growth characteristics. Additional polyploid series will be produced. From selections made in the field in the spring of 1947, the most desirable tetraploids will be placed in an isolated polycross nursery for combining value and for seed increase. Additional cytological studies of commercial stocks have not uncovered any naturally occurring tetraploids.

Title: Fertilizers for Birdsfoot Trefoil under Pasture Conditions.

Leaders: A. R. Midgley and K. E. Varney.

There is increasing interest in the use of birdsfoot trefoil as a pasture and hay crop in Vermont. Therefore, an extensive fertilizer trial was started in the spring of 1946 on two distinctly different soil types to determine what is needed for its best growth. The companion grass or rate of fertilizer used varied somewhat with the soil type. On the light sandy soil, a mixture of brome and tall oat grass was used and the fertilizers were predominately high in potash. On the heavy clay soil, reed canary grass with predominately high phosphate fertilizers was used. These selections seemed advisable in view of some preliminary results. In all cases different fertilizer rates and ratios including some minor elements were used. No data are yet available, but there seemed to be a marked response from high potash fertilizers on the light soil type. It is possible that insufficient available potash is responsible for the poor stands of birdsfoot usually experienced on these soils in the past. This plant usually does very well on our heavy clay soils which have a high potash content.

Title: Longevity of Birdsfoot Trefoil and Zigzag Clover Seeds.

Leaders: K. E. Varney and A. R. Midgley.

Birdsfoot trefoil is considered to be a long-lived legume but it seems likely that this is partly due to its ability to reseed itself even when pastured rather closely. One pasture of several acres in Vermont is considered to be at least 50 years old. Once the plant is established and a good seed crop produced, it is likely that a sufficient "reservoir" of "hard" seed is available in the soil to last for many years. In one instance, at least, a good crop

of volunteer trefoil was obtained after an old field had been reseeded to bring the seed near the surface again. A crop of corn had been grown between the time of reseeding. To determine the longevity of birdsfoot trefoil and zigzag clover, ten samples in duplicate of 200 seeds each were mixed with soil, placed in large glass tubes open at each end, and buried at plow depth in a horizontal position. These will be sampled and germination studies made at yearly intervals. These were buried in spring of 1946 in a light sandy soil and also a very heavy soil in the Champlain Valley. No data are available as the first samples will be removed next spring.

Title: Fertilizer Placement Studies for Alfalfa, Birdsfoot Trefoil and Ladino Clover.

Leaders: A. R. Midgley and K. E. Varney.

One-acre plantings of each of the above legumes with brome grass were made in the spring of 1946. Each acre received 10 loads of manure and to each load 100 pounds of an 0-20-20 fertilizer and 5 pounds of borax were added. On half of the plots, the manure-fertilizer was applied before plowing (plowed under), the other half received the same treatment after plowing (near surface, harrowed in). Very good stands were obtained, but considerable winterkilling occurred, making the areas too spotted to get good yield data. However, observations showed that with a rather shallow rooted plant like Ladino clover greater growth and spread resulted with the fertilizer near the surface. In fact, it grew too well because it crowded out the other vegetation (grass and weeds) and with severe winterkilling there was very little vegetation left the following spring. The deep-rooted alfalfa plant, however, seemed to do better with the deeper fertilizer placement. Birdsfoot trefoil was in between but seemed to show a slight preference for that nearer the surface. Since there seemed to be a rather large amount of "hard" seed which germinated the second year, there is again present a good stand of these legumes on the two different fields under test. These should supply yield data next year.

WEST VIRGINIA AGRICULTURAL EXPERIMENT STATION

Title: Pasture Fertilization Studies.

Leaders: F. W. Schaller and G. G. Pohlman.

This study now concerns primarily rates and frequencies of phosphate applications to permanent pastures. This experiment was started in 1940. Weather conditions were favorable the present year and yields were highest since 1943. The yield of dry forage obtained from any treatment was dependent mainly on the total amount of phosphate received during the 7-year period. However, the plots which received all the phosphate at

the beginning of the experiment are now yielding considerably lower than those receiving split applications. On the other hand, where the phosphate is divided into one-, two- or four-year applications the yields are about the same.

The botanical estimates show a greater percentage of desirable species on the plots having the higher rates of phosphate application and as was true of the yields are lower on the plots which received all the phosphate in the initial application. The percentage of white clover has increased sharply over that of 1945 and is undoubtedly a factor in the higher yields this year.

Title: Revegetation of Hill-land Pastures in West Virginia.

Leaders: R. M. Smith, D. R. Browning, G. G. Pohlman, and F. W. Schaller.

Most of the experiments under this project have been completed and were discontinued in 1946. The results have been summarized and reported in an Experiment Station bulletin.

Yields and botanical estimates were obtained on a few of the old areas this year. The data show that on areas where the grazing was continuous and close after the first year, the surface-treated plots are now yielding about the same as the renovated plots. On these latter plots the tall growing legumes and grasses with the exception of orchard grass have now been largely replaced with Kentucky bluegrass and white clover. Birdsfoot trefoil has also withstood the grazing but its spreading and growth has been very slow. On areas where grazing has been controlled Ladino clover-orchard grass mixtures are showing much promise. In Wetzel County grazing records reported by one farmer on a 3-acre pasture of Ladino clover-orchard grass show a carrying capacity of approximately one cow per acre for a 6-months' period.

A new experiment is now underway to test the feasibility of using calcium cyanamid as a killing agent prior to renovation. Calcium cyanamid at the rate of 1500 pounds per acre has been applied to poor pasture and meadow sods. Three times of application are being tested, namely, October 15, November 15 and December 15. In early spring the treated areas will be seeded with mixtures of alfalfa-orchard grass, Ladino clover-orchard grass, and birdsfoot trefoil-orchard grass. Yield data, stand counts and chemical composition will be obtained.

Title: Reclaiming Eroded Soils.

Leaders: G. G. Pohlman, R. M. Smith and D. R. Browning.

Soil samples were taken and observations made on eroded areas at various locations in the state. On the areas protected from grazing sweet clover, alfalfa, birdsfoot trefoil, Korean lespedeza, and Lespedeza sericea are making considerable growth in the various trials. The grasses showing most promise are lovegrass, tall oat grass, orchard grass and redtop. Bromegrass is doing well on some areas, but is rather poor on others. The unprotected areas are heavily grazed because they represent small areas of good herbage in an area of poor vegetation. Under these conditions lovegrass and birdsfoot trefoil appear to be the most promising; the lovegrass because of its lower palatability and the birdsfoot trefoil because of the nature of growth.

The reclamation of eroded land seems feasible but it must be carefully handled for some time after cover is established. It is suitable for limited use as hay or pasture.

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